

# MALARIA CONTROL IN WAR AREAS



1944-45

FEDERAL SECURITY AGENCY

U.S. PUBLIC HEALTH SERVICE



# turning Ma CONTROL

IN WAR AREAS  
1944 - 45



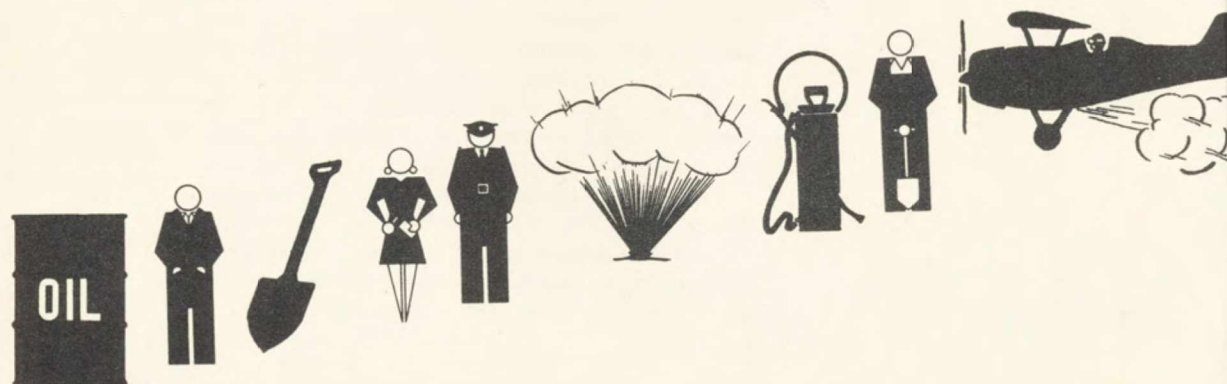
The Malaria Control in War Areas program, established in March 1942, is a joint undertaking by the U. S. Public Health Service and State Health Departments. The original objective was to reduce the hazard of malaria transmission in extra-cantonment military and essential war industry areas by supplementing the control measures of military authorities within the reservation. Concentration of malaria carriers in military hospital and prisoner-of-war camps created the necessity for protecting the civilian population from infections which could originate in these military areas. Return of malaria carriers from overseas caused further expansion of control measures to non-military zones. Critical appraisal of areas in which malaria transmission may occur is based on medical, engineering, and entomological investigations. In malarious areas operations are directed against the insect vectors of the disease. In this way coordinated forces offset the danger of an increase in malaria — the disease which has earned the reputation of being the worst of human scourges.

**FEDERAL SECURITY AGENCY - U. S. PUBLIC HEALTH SERVICE**



# CONTENTS

RETURNING MALARIA CARRIERS . . . . .	1
ORGANIZATION FOR MALARIA CONTROL . . . . .	4
WAR AREA PROGRAM . . . . .	8
EXTENDED PROGRAM . . . . .	14
TRAINING PROGRAM . . . . .	26
AEDES AEGYPTI PROGRAM . . . . .	30
INVESTIGATIONAL PROGRAM . . . . .	35
Imported Malaria Studies, Columbia Lab., NIH . .	36
Emory University Field Station . . . . .	38
Carter Memorial Laboratory, Savannah, Ga. . .	40
DDT Investigations, Memphis Laboratory, NIH . .	51
Malaria Field Studies — South Carolina . . .	52
MALARIA CONTROL IN THE STATES . . . . .	56





# Returning Malaria Carriers

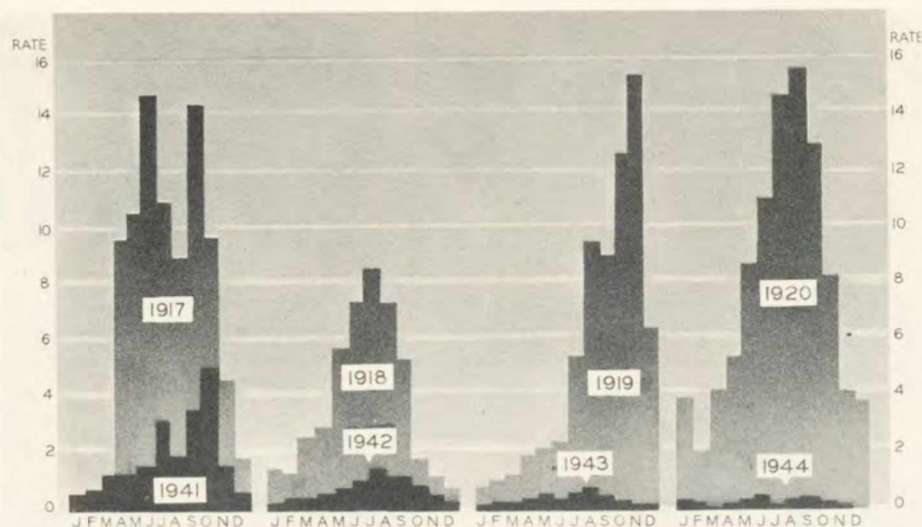
The Office of Malaria Control in War Areas (MCWA) was established in March 1942. During the first season the program was confined to extra-cantonment zones of military areas and to essential war industries. The work complemented malaria control activities of military authorities within reservation limits.

During 1943 training and war production were still the main themes of the war effort. The tremendous expansion along these lines involved mass migration of millions of draftees and war workers into the South where the climate was not only favorable for year around training but also for malaria transmission. In spite of acute shortages of men and materials, MCWA expanded during this period to keep pace with the war area problem.

1944 saw the first change in program objectives and emphasis. As the casualty figures mounted, Army general hospitals and Navy hospitals were filled. Prisoners were held not only in main camps but in temporary branch camps in areas where temporary labor was needed. These were new war areas and were more hazardous than regular military reservations since they provided greater concentrations of malaria carriers than were present elsewhere







Malaria Admissions per Thousand Men per Year for the Army in the Continental United States. World War I — World War II. (U. S. Army)

in the United States. Here for the first time there arose the necessity for protecting the civilian against military malaria in addition to the earlier necessity for protecting troops from the civilian reservoir of the disease.

Within the southeastern United States where malaria is endemic, this problem was met by existing MCWA facilities. In the marginal or nonendemic states mosquito vectors occurred in sufficient numbers in close proximity to hospitalized malaria carriers and infected prisoners-of-war to present a serious hazard. Mobile units were commissioned to cope with this situation. These units were equipped for routine survey and for emergency control work. Under the direction of an experienced malaria control officer, they covered circuits of military installations in the northern and western states and performed the tasks deemed necessary for the protection of the public.

By 1945 the shift in emphasis was complete. The downward trend of malaria cases had been uninterrupted and malaria admissions among troops in continental United States had reached an all-time low.

Meanwhile, service men were returning in increasing numbers, many of them from hyperendemic areas and some of them active malaria carriers. Although the

greatest danger will come still later when large-scale demobilization takes place, civilian cases of malaria have already been traced to these returning carriers. In anticipation of this, plans were made early in 1945 for the so-called "Extended Program" which was inaugurated at the beginning of the 1945 mosquito breeding season.

The Extended Program is designed to meet the impact of returning malaria carriers. It shifts the scene from potentially hazardous war areas to actually malarious endemic foci. This shift is based upon the principle that imported malaria is most likely to manifest and perpetuate itself in places where the presence of the disease proves that conditions are ideal for its transmission. In these important malarious areas, cities are being protected by the usual methods — drainage and larviciding — and houses in small towns and rural areas are being treated with residual spray applications of the remarkable new insecticide, DDT. The residual spray program is based upon the premise that the mosquitoes most likely to become infective are those found resting on the walls and ceilings of homes occupied by man. Killing these particular mosquitoes before the parasites have completed their



cycle interrupts the chain of transmission at its most vulnerable point.

Other disease and pest control programs have long been associated with MCWA, though on a relatively small scale in comparison with the whole effort. *Aedes aegypti* control was instituted in June 1942 as a precaution against the reestablishment of dengue or yellow fever in this country. Over 4 million premise inspections have been made and epidemics of these diseases have not occurred within the continental United States during the present war. Dengue broke out in Honolulu in 1943 and was brought under control early in 1944 by a cooperative effort of the Territorial Board of Health, MCWA, and military personnel. Currently this program is maintained in order to incorporate anti-*aegypti* measures into the sanitation programs of vulnerable cities to hold trained personnel for possible epidemics.

Dog fly control, started during the first months of MCWA, was necessary in a few areas because of the serious effect of these pests on certain Army bases. Dog fly control is carried on in cooperation with the Bureau of Entomology and Plant Quarantine for the purpose of protecting Army Air Force training bases along the seriously infested northwest coast of Florida. Beach deposits of marine grasses in which the flies breed are treated with dilute creosote sprays or, more recently, with DDT sprays. Reports for the 1944 season were most favorable, no annoyance from the vicious biting flies having been reported on the military reservations within the control areas.

Early in the MCWA program it became evident that the public is often more interested in avoiding mosquito bites than in preventing disease. The concept of species sanitation — e.g. control of disease vectors only — is logical and economical but less comfortable in practice than general control of all mosquitoes. In spite of the very human desire to be comfortable, MCWA funds

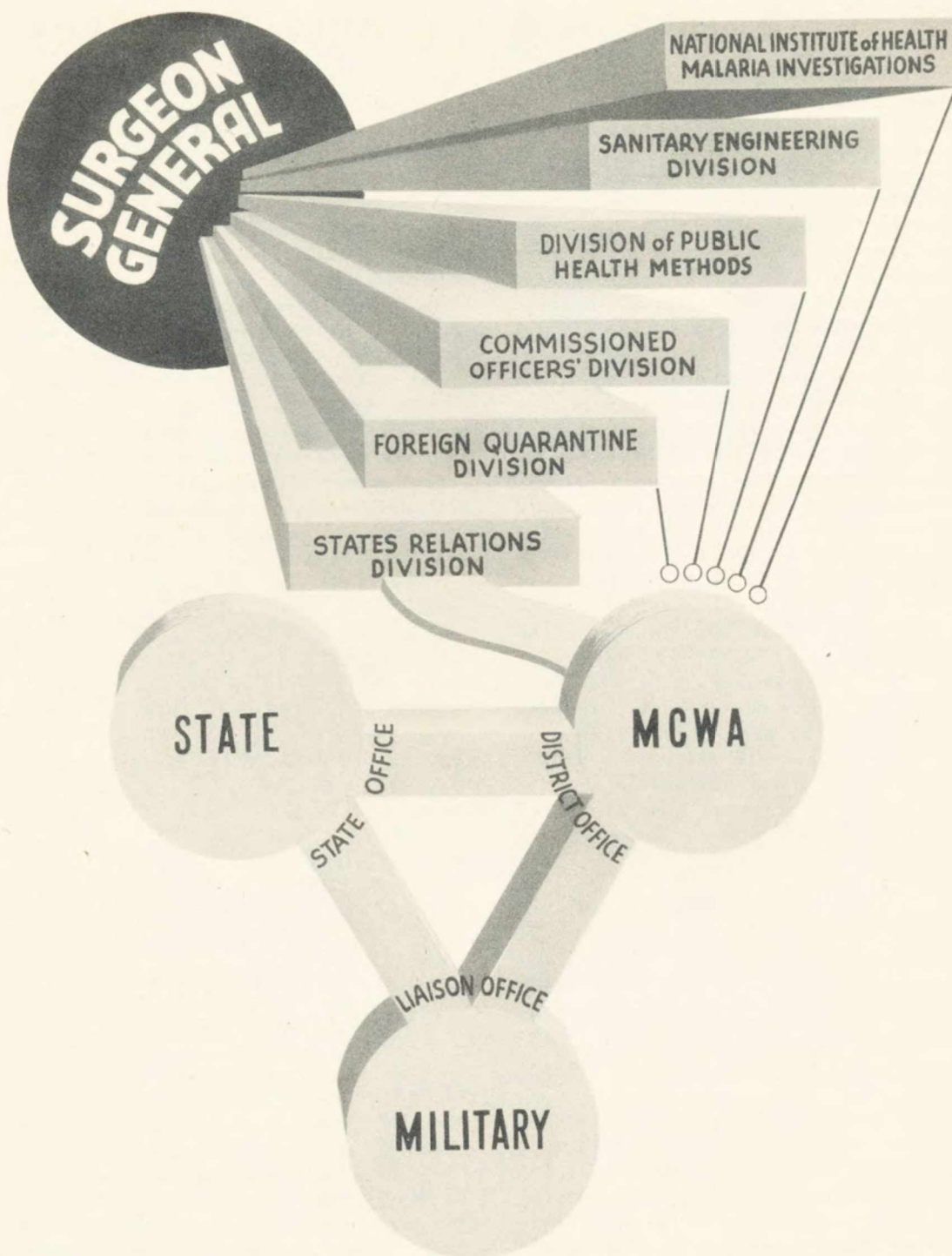
were limited strictly to use against disease vectors. Work undertaken against the so-called "pest mosquitoes" was restricted to places where military training or essential war work was seriously hindered. By cooperative agreement with the various Army Service Commands, work of this type was authorized in 1944 on a reimbursement basis.

The returning carrier problem of 1944 and 1945 was not limited to malaria. Theoretically every disease that plagues mankind may be introduced by our troops which are returning this time from the most disease-ridden countries of the world. Actually our men are being protected by phenomenal wartime methods and are receiving the very best of medical care. However, tropical diseases have already been introduced and the problem may become even more acute with the postwar expansion of air commerce.

The first step in meeting this emergency is to train practicing physicians and medical technicians in the diagnosis of tropical and parasitic diseases. In 1945 such a training program was established under MCWA. In this connection training materials have been prepared for use in schools for technicians and for distribution to state diagnostic laboratories and to medical schools.

Looking to the future we visualize a broad program of prevention of insect-borne diseases. Malaria and mosquitoes, endemic typhus and fleas — to mention only two of the already existing situations, will demand aggressive control measures. Federal activities will be limited to the following services which are beyond the facilities of individual states: 1) Vocational-internship type of training and production of visual and other training aids; 2) Specialized epidemiological service including surveys and laboratory and field studies; 3) Development of equipment, materials and operating techniques for improving field control measures; 4) Cooperative tropical and related disease control demonstrations with state health departments, and operational assistance in emergencies.





# **MALARIA CONTROL IN WAR AREAS**

## **LINES OF AUTHORITY AND INTERRELATIONS**

## **ORGA**

Malaria C  
Office of t  
sion. Its li  
the Surgeon  
of State Ser  
tions Divis  
with other  
visions suc  
Public Heal  
ineering, C  
the Nation

MCWA ma  
tary author  
commands t  
vice liais  
through St

Each St  
through ex  
nels. Assi  
quarters  
sonnel, 2  
3) materi  
4) techn  
assistance  
fiscal ma

Withi  
malaria c  
sible for  
work. In  
and a sta  
field wo  
entomolo  
Health Se  
availabl  
and guid  
250 "wa  
ing the  
were 150  
Aedes ae

Pers  
of the  
officer:  
vice pe  
scienti  
sional,  
dial e  
render  
vided b  
by a nu  
contro

## ORGANIZATION FOR MALARIA CONTROL

Malaria Control in War Areas is an Office of the States Relations Division. Its lines of authority stem from the Surgeon General through the Bureau of State Services and the States Relations Division. Interrelations exist with other Public Health Service Divisions such as Foreign Quarantine, Public Health Methods, Sanitary Engineering, Commissioned Officers, and the National Institute of Health.

MCWA maintains liaison with military authorities in the various service commands through Public Health Service liaison officers and operates through State health departments.

Each State directs its own program through existing administrative channels. Assistance from the Atlanta headquarters consists of 1) trained personnel, 2) specialized equipment, 3) materials under wartime priority, 4) technical consultation, and 5) assistance with administrative and fiscal matters.

Within the States a director of malaria control activities is responsible for over-all supervision of the work. In most cases a state engineer and a state entomologist supervise the field work. An MCWA engineer and an entomologist are assigned to Public Health Service district offices and are available for technical consultation and guidance when needed. A total of 250 "war areas" were in operation during the year. In addition to this there were 150 Extended Program areas and 15 *Aedes aegypti* control areas.

Personnel on duty for all or part of the year included 300 commissioned officers, and the following Civil Service personnel: 75 professional and scientific employees, 600 subprofessional, 200 clerical, and 3000 custodial employees. Additional help is rendered by numerous employees provided by state and local agencies and by a number of men assigned to dengue control in Hawaii by the Army.

Within the headquarters office, organization is along the lines of professional services. Five divisions are set up for administration of Medical, Entomological, Engineering, Training, and Administrative (fiscal) matters, respectively. These divisions are further divided into units charged with responsibility for specific types of work as indicated by their titles on the accompanying chart. Three independent units are directly responsible to the Executive Office as indicated.

The Administrative Division handles all fiscal matters. This includes personnel recruitment, classification and placement; preparation of budgets and processing of pay roll and travel vouchers; and procurement, distribution and repair of equipment.

As in past years, personal services accounted for a large proportion of the MCWA budget. The relative expenditures for personal services as compared with supplies, equipment, contractual services, and transportation are shown in the accompanying table.

Major items of equipment are likewise shown. This gives a very incomplete picture of the total of 1,046 separate items on property records ranging from \$12,000.00 draglines to rat traps.

Field and laboratory investigations play a vital role in translating the results of pure research into practical field operations. This work is guided by headquarters personnel and is carried out by designated officers who are in charge of particular projects. Among the projects carried on during the past year may be mentioned the Carter Laboratory at Savannah, Georgia, the DDT Residual Spray Study in South Carolina, Imported Malaria Studies in cooperation with the National Institute of Health at Columbia, S. C., the Emory University Field Station at Newton, Georgia, investigations in cooperation with the Tennessee Valley Authority, and other special investigations.



# MCWA HEADQUARTERS OFFICE

OFFICER IN CHARGE  
EXECUTIVE OFFICER  
COMMISSIONED OFFICERS' UNIT  
EQUIPMENT UNIT  
RECORDS & STATISTICS UNIT

## TRAINING DIVISION

*IN-SERVICE TRAINING*

*EDITORIAL*

*TRAINING AIDS*

*PUBLIC RELATIONS*

*PROFESSIONAL RELATIONS*

## MEDICAL DIVISION

## ENGINEERING DIVISION

*DENGUE CONTROL*

*MALARIA CONTROL*

*IMPOUNDED WATERS*

## ENTOMOLOGY DIVISION

## ADMINISTRATIVE DIVISION

*PERSONNEL*

*BUDGET & FISCAL*

*PROCUREMENT & SUPPLIES*

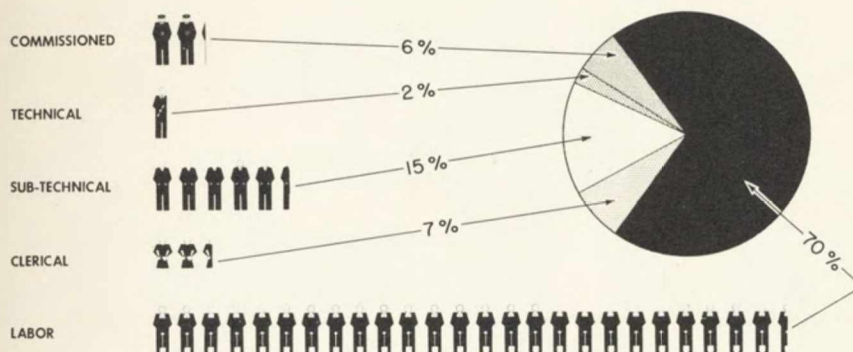
*DRAFTING, REPRODUCTION  
& DISTRIBUTION*

TECHNICAL DEVELOPMENT  
CARTER MEMORIAL LABORATORY Savannah, Ga.  
MALARIA FIELD RESEARCH, South Carolina

COMMISSIONED  
TECHNICAL  
SUB-TECHNICAL  
CLERICAL  
LABOR  
EQUIPMENT  
CONTRACT  
SERVICES  
SUPPLIES  
MATERIAL  
TRANSPORT  
PERSONNEL  
SE  
POWER  
AIR  
AUTO  
HAND  
HAND

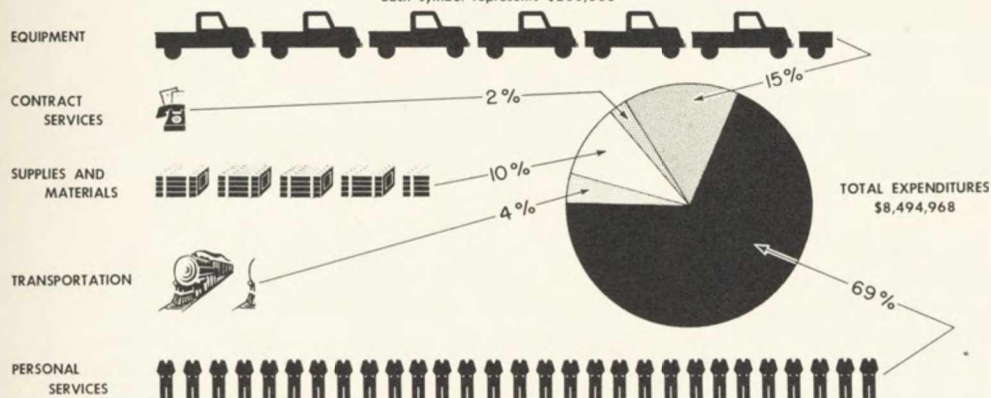
## PERSONNEL

Each symbol represents 100 people



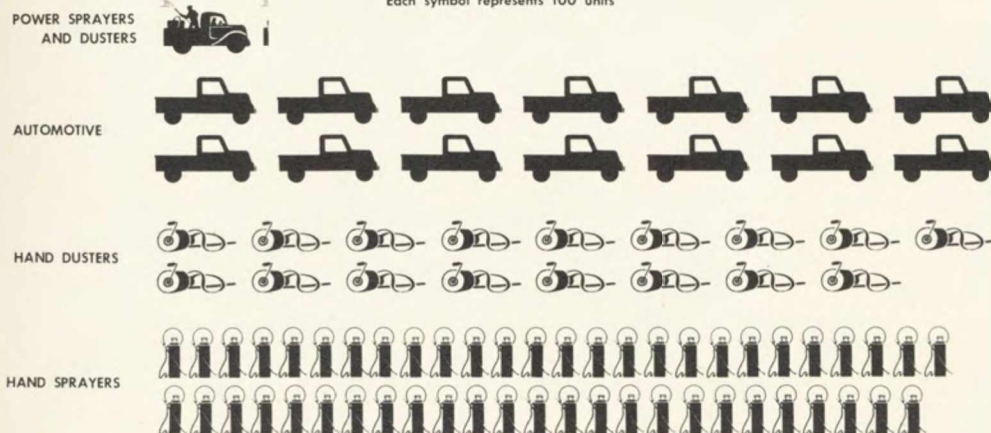
## EXPENDITURES

Each symbol represents \$200,000



## EQUIPMENT

Each symbol represents 100 units





# ARMY-NAVY-WAR INDUSTRIES PUBLIC HEALTH SERVICE COOPERATION

INTRA-RESERVATION  
MILITARY OPERATIONS

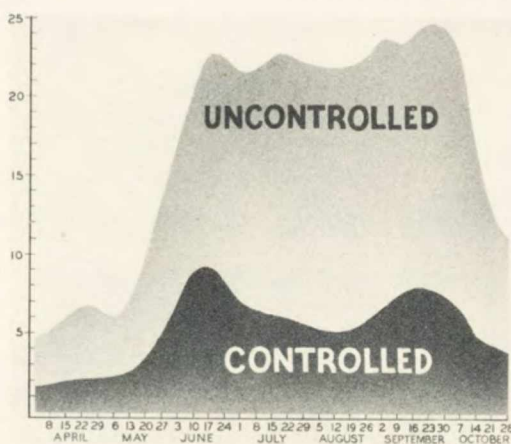
EXTRA-RESERVATION  
USPHS OPERATIONS

## WAR AREA PROGRAM

As in past years, the war area program employed conventional control measures directed against the larval forms of the principal malaria vectors, *Anopheles quadrimaculatus* Say, *Anopheles freeborni* Aitken and *Anopheles albimanus* Wied. Operating around critical war establishments, this program has contributed to the protection of military and other war-essential personnel. This work complements that which the Army and Navy carry on in cantonment areas. It is purely preventive and is based upon the

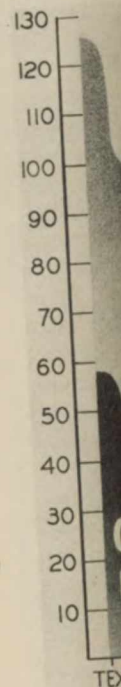
thesis that the presence of malaria vectors is a potential hazard, even though actual malaria cases may not

be demonstrable in an area at any particular time. Since the control program is based upon the mosquito vector rather than on malaria, its success should be judged in terms of mosquito reduction. However, the decrease of the disease within the Army in continental United States is so clear and spectacular that it should not be overlooked in this connection.



Densities of *Anopheles quadrimaculatus*, *freeborni*, and *albimanus* in controlled versus uncontrolled areas.

Mosquito  
guide for  
point the  
control and  
luating the  
ished job.  
single stat  
tected area  
peaks of 9  
— as compar  
raging 23  
an arbitra  
set as a m  
considered  
catching s  
son's work  
factory. WI  
persist in  
for a per  
the zone i  
Zones in  
which wer  
season and  
whelming  
factory  
maintaine



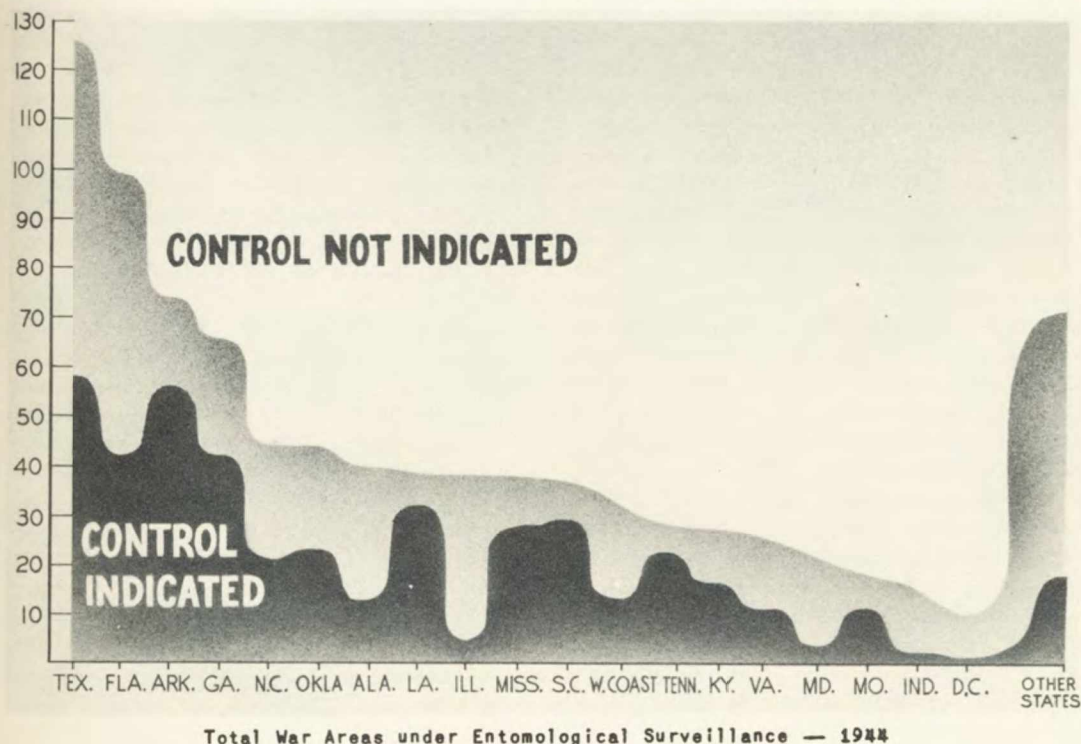
## ENTOMOLOGICAL EVALUATION

Mosquito densities are a reliable guide for control operations. They point the way to places in need of control and provide a means of evaluating the effectiveness of the finished job. An average of the highest single station counts *inside* of protected areas for the 1944 season shows peaks of 9 in June and 8 in September — as compared with outside counts averaging 23 and 24 respectively. Since an arbitrary figure of 10 has been set as a maximum number of mosquitoes considered to be safe in any adult catching station in a zone, the season's work may be considered as satisfactory. When over 10 female mosquitoes persist in any resting place in a zone for a period of three or more weeks, the zone is classed as unsatisfactory. Zones in this category included many which were newly activated during the season and those presenting such overwhelming control problems that satisfactory low densities could not be maintained at all times.



Collecting Mosquitoes in Chloroform Tube

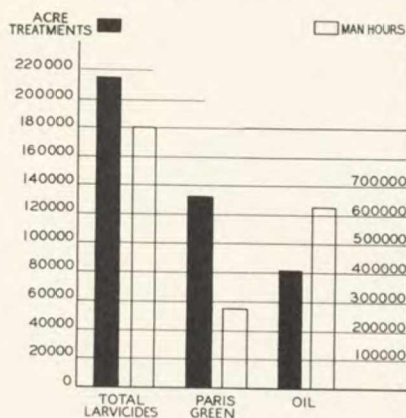
Entomological survey and surveillance activities serve to restrict control operations to those areas where significant vector densities exist. The chart below shows that the number of zones, in which unnecessary control was avoided by these activities, is approximately equal to the number of zones in which anopheline control was prosecuted. This represents a hypothetical saving equivalent in extent to the project operations actually performed.



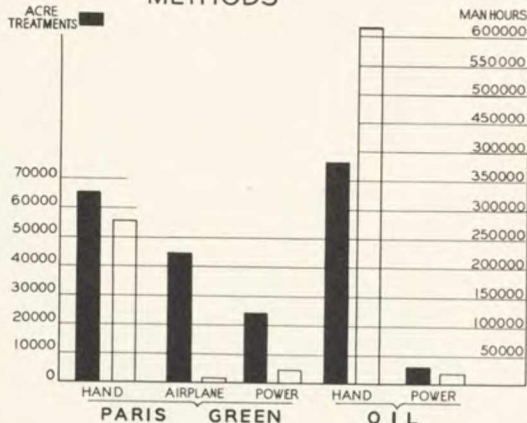


# LARVICIDAL OPERATIONS

## SUMMARY



## COMPARATIVE METHODS



As in previous years the principal control operation of MCWA was application of larvicides. Next in terms of man-hours was drainage maintenance. Major and even minor drainage projects were few in number and limited in extent.

**LARVICIDES.** Paris green and oil were the two principal larvicides used on the MCWA program. A review of the year's activities reveals that in terms of acre-treatments, parisgreen was the more extensively used larvicide. However, in terms of man-hours expended in distribution, it was greatly surpassed by oil. Paris green was used extensively in Puerto Rico and Jamaica because, under the variety of *albimanus* breeding conditions, it has proved to be the most economical and effective larvicide. It is more suitable than oil for distribution where anopheline breeding is associated with dense vegetation and heavy flottage. During 1945 132,726 acres were larvicided with paris green at an average cost of \$2.01 per acre-treatment.

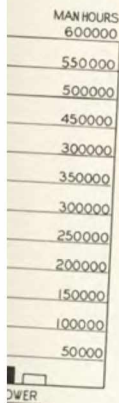
Oil larviciding was performed in 174 areas of 27 states. Diesel or fuel oil No. 2 was used in most instances. The principal advantage to be gained by the use of oil is that control of general mosquitoes is accomplished in the areas treated — in short, pest mosquito control as well as malaria vector control. During 1945 about

100,000 acres were larvicided with oil at an average cost of \$5.90 per acre-treatment.

**APPLICATION OF LARVICIDES.** Hand larviciding was used less extensively this year than in any previous year. This was due to better selection of methods as a result of several seasons' experience and to an increased need for labor conservation in most areas. Of 214,666 acres treated with paris green and oil, 34.2% of the applications were made with power equipment including airplane dusting. Last year about 20% of the acre-treatments were by power equipment. Saving in man-hours by use of power equipment is graphically illustrated on the basis of MCWA operations for 1944-45.

**TIME-COST DATA ON LARVICIDING.** Over 80% of MCWA funds are expended for personal services. It has been shown that the basic field operation is larviciding. Hence it is here that the greatest saving may be accomplished by increasing the efficiency and thus decreasing the man-hours expended on the job. From a field study it was determined that the foreman is the key man in maintaining a high level of efficiency. Training and careful planning at this level can perhaps do more than anything else to improve the control program.





vicided with  
of \$5.90 per

CIDES. Hand  
extensively  
vious year.  
selection of  
several sea-  
an increased  
ion in most  
reated with  
4.2% of the  
with power  
ne dusting.  
acre-treat-  
ment. Sav-  
of power  
illustrated  
ations for

IDING. Over  
pended for  
been shown  
eration is  
here that  
be accom-  
efficiency  
-hours ex-  
field study  
e foreman  
ng a high  
and care-  
an perhaps  
o improve



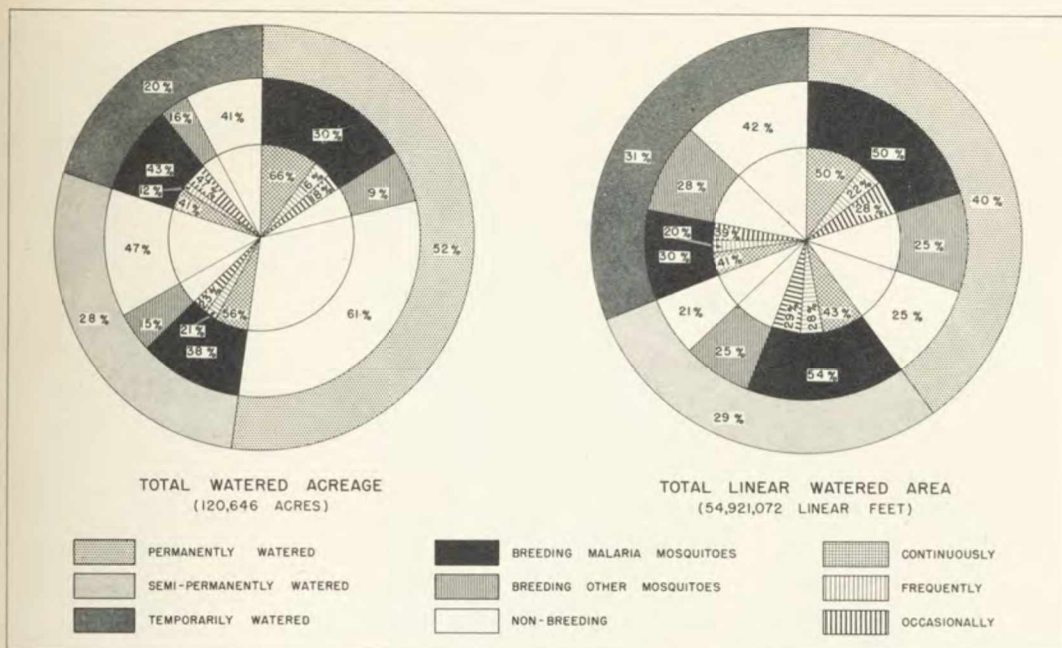




Drain  
included  
tion, fil  
nent line  
struction  
structure  
year 194  
mained  
program i  
Completi  
blished  
military  
in most

To d  
blem an  
drainag  
was con  
through  
120,646  
ported.  
was cla  
perman  
tion t  
feet o  
and ot  
in wid  
one-t  
area  
mosqu  
plus :





### DRAINAGE

Drainage activities for the year included machine and dynamite excavation, filling, installation of permanent lining, ditch stabilization, construction of cross-drains and outlet structures. At the close of the fiscal year 1945, little major drainage remained to be done on the war areas program in the continental United States. Completion of drainage in most established areas, inactivation of some military bases, and the end of expansion in most states were responsible for this.

To determine the extent of the problem and the percent eliminated by the drainage, a census of watered areas was conducted during the winter of 1944 throughout the war areas. A total of 120,646 acres of watered area were reported. Fifty-two percent of this area was classified as permanent, 28% semi-permanent, and 20% temporary. In addition to the above, 55 million linear feet of water-holding ditches, canals and other watered courses under 10 feet in width were reported. Somewhat over one-third of each class of watered area was found to be breeding malaria mosquitoes. This acreage (42,177 acres plus 25 million linear feet of ditches)

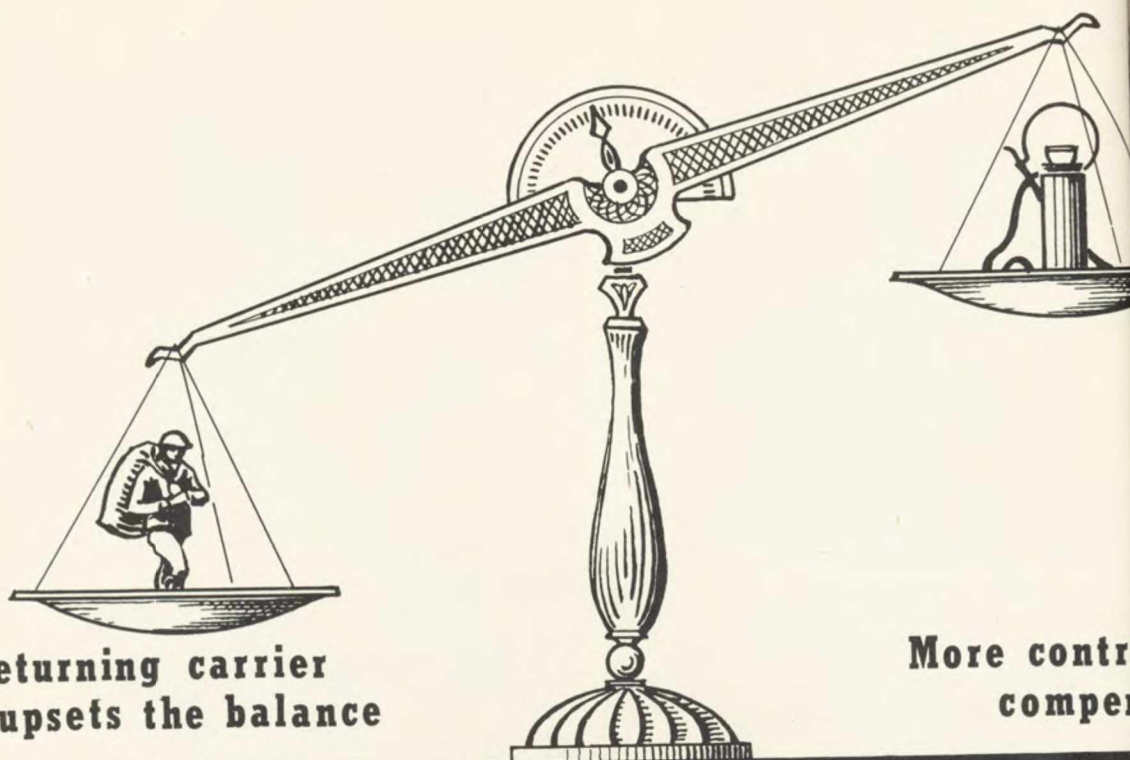
probably represents the significant acreage of watered area from the standpoint of MCWA. It was further reported that 15,000 acres and 680 thousand linear feet of watered area have been eliminated by drainage during the course of MCWA operations.

A summary of various types of drainage activities is given for the past year. Hand excavation cost an over-all average of \$1.57 per cubic yard; dynamite ditching \$0.58 and machine drainage \$0.42.

### FUTURE DEVELOPMENTS

For the future we may expect significant developments along two lines. First, the development of the new larvicide, DDT, may profoundly alter the picture. DDT is effective in such small quantities that real savings in the critical matter of man-hours required for application may be attained. Secondly, power equipment designed for application of DDT as a smoke or thermal aerosol may completely revolutionize control operations. Work is progressing on these and other points and results should become incorporated into field practice as soon as materials and equipment can be released in sufficient quantity.





**Returning carrier  
upsets the balance**

**More contro  
compen**

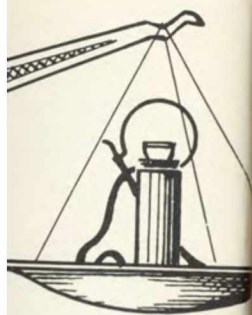
## EXTENDED PROGRAM

The Extended Program is a comprehensive plan designed to meet the hazard of large numbers of malaria carriers returning from military service. Other things being equal, the addition of these active malaria carriers upsets the present favorable balance and creates a serious menace to public health in the United States. Estimates vary as to the number of active carriers to be expected but whether it be one thousand or one million, local outbreaks may be expected because it has been proven that our mosquitoes can carry exotic strains of malaria and the first locally acquired cases stemming from a World War II veteran were reported a few months ago.

Malaria carriers will return to every state and to most towns and crossroads throughout the country. Complete protection over such a vast territory would be infeasible. Therefore, attention has been concentrated in those areas where, by the continued presence of malaria, it is known that optimum conditions exist for transmission. In these endemic areas an intensive attack on malaria vectors is being waged.

Drainage and larviciding are the methods of choice in towns of 2,500 or more people. But malaria is a rural disease. Heretofore there has been no economically feasible method of carrying malaria control to the individual tenant farmer or share cropper. Now,

DDT HOUSE SPRAY  
is toxic to m  
for the first  
able — the  
spray to wal  
DDT resid  
a layer of c  
face. For se  
are toxic t  
Anopheles qu  
upon walls  
blood meal.  
mosquitoes  
and fed on  
most likely  
malaria ch  
necessary  
treated su  
killed but  
death may  
Dichlo



More control  
compensate

A M

return to every  
and crossroads  
Complete pro-  
territory would  
, attention has  
se areas where,  
ice of malaria,  
conditions exist  
e endemic areas  
malaria vectors

aiding are the  
ms of 2,500 or  
ia is a rural  
re has been no  
thod of carry-  
the individual  
cropper. Now,



DDT HOUSE SPRAYING. The DDT spray emulsion evaporates leaving a layer of crystals which is toxic to mosquitoes upon contact for several months.

for the first time, a method is available — the application of DDT residual spray to walls and ceilings of homes.

DDT residual spray evaporates leaving a layer of crystals on the treated surface. For several months these crystals are toxic to mosquitoes upon contact. *Anopheles quadrimaculatus* commonly rests upon walls and ceilings after taking a blood meal. By killing these particular mosquitoes which have entered houses and fed on human beings and thus are most likely to have become infected, the malaria chain is broken. It is only necessary for a mosquito to rest on a treated surface for a few minutes to be killed but DDT is slow to take effect so death may not occur for several hours.

Dichloro-diphenyl-trichloroethane,

or DDT, was first synthesized over 70 years ago but its insecticidal properties were not realized until 1939, and it did not reach this country until 1942. Because of military urgency years of research were crowded into the brief span of the war months. Under the general supervision of the Office of Scientific Research and Development tests were run by many agencies in laboratories and in the field, at home and on the battlefronts. MCWA investigations were concentrated on the technic of application of the material as a residual spray in practical field operations. The methods developed at the Carter Laboratory, Savannah, Georgia, and in field tests in Arkansas and Puerto Rico are now being used on the Extended Program.



## EPIDEMIOLOGY

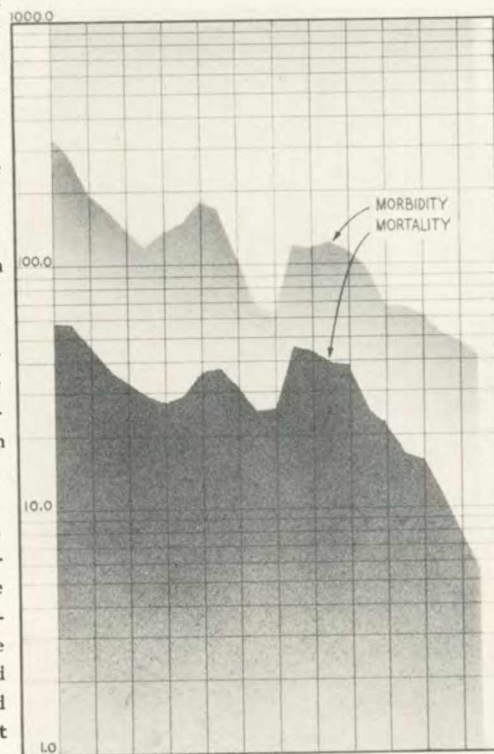
The problem of precisely delimiting the endemic foci of malaria was most difficult. Whether malaria spreads outward from endemic foci in times of resurgence or gradually comes out of hiding throughout its range is a moot question. In either case, practical control measures depend upon delineating endemic foci as accurately as possible.

It was found that malaria mortality as reported by counties left much to be desired but was the most reliable method available short of expensive and time-consuming technics which are still in an experimental stage. Mortality data also are useful in following trends and are supported by morbidity data as shown in the accompanying graph. In addition to the general downward trend, three peaks are clearly evident. Because the three cycles evident since 1920 are not equally spaced they cannot be used accurately to predict the next cyclic increase of malaria. However, inspection of the chart would indicate that this increase is overdue. The reasons for its failure to materialize between 1939 and 1944 are not clear.

Mortality data also provide an objective criterion of the relative "weight" of the malaria problem in the various States. However, within the States the county distribution of malaria mortality may not delineate the problem sufficiently closely

for practical control purposes. Hence, within States, areas selected for control operations vary somewhat from those dictated solely by county distribution of mortality. Such deviations are made largely in consultation with State and local health officers and are based upon their intimate knowledge of local conditions.

The extent of the problem of endemic foci of malaria is shown in the



Malaria Morbidity and Mortality Rates per 100,000 Population in all States reporting - 1920-1943.

accompanying table. A mortality rate of 10 per 100,000 population has been set as a threshold of malaria significance. It is believed not only that the bulk of the malaria problem is represented by the counties reporting rates of 10 or over but that operations involving a population of that magnitude are practicable.

Counties with rates of 10 or more per 100,000 population number 188 in 13 States. According to Bureau of Census figures 957,425 homes are included in the rural portions of these counties.

The remainder of the endemic malaria problem is scattered over 649 counties with mortality rates from 0.1 to 9 per 100,000 population. It is proposed to attack this problem by residual spraying of individual homes where the presence of malaria has been confirmed by a positive blood slide or by a positive history of malaria on the part of returned service men. On the arbitrary assumption that there are about 400 cases for each malaria death the number of homes to be treat-

ed in the estimated number of homes

Alabama  
Arkansas  
Florida  
Georgia  
Kentucky  
Louisiana  
Mississippi  
Missouri  
North Carolina  
Oklahoma  
South Carolina  
Tennessee  
Texas

ed in these marginal counties has been estimated by multiplying the average number of deaths by 400. The resulting figure, 264,800, added to the number of homes in regular Extended Program

counties, gives a total of 1,222,225 homes as the goal for fairly complete coverage. This figure may be low if an attempt is also made to spray homes of returned military carriers.

TABLE I

*Number of counties and homes per state with malaria rates of 0.1 to 9 and 10 or over per 100,000 population respectively.*

STATE	COUNTIES WITH RATES OF 10 OR MORE PER 100,000 POPULATION		COUNTIES WITH RATES OF 0.1 — 9 PER 100,000 POPULATION		TOTAL HOMES	% OF TOTAL
	NO. COUNTIES	NO. HOMES**	NO. COUNTIES	NO. HOMES*		
Alabama	19	118,833	42	29,280	148,133	12.06
Arkansas	32	198,298	37	21,200	219,498	17.88
Florida	25	70,627	36	16,000	86,627	7.06
Georgia	33	93,732	80	22,560	116,292	9.47
Kentucky	2	5,711	36	7,040	12,751	1.04
Louisiana	9	48,309	50	28,800	77,109	6.28
Mississippi	20	114,308	59	30,160	174,468	14.21
Missouri	5	37,182	44	8,080	45,262	3.69
N. C.	4	18,779	49	15,360	34,139	2.78
Oklahoma	2	13,758	43	15,040	28,798	2.34
S. C.	15	85,810	26	18,080	103,890	8.46
Tennessee	4	20,451	51	21,920	42,371	3.45
Texas	18	101,627	96	36,880	138,507	11.28
TOTAL	188	957,425	649	270,400	1,227,825	100.00

\* Number of Homes : 400 x average number of deaths reported annually

\*\* From Bureau of Census volume on Housing, 1940. Total includes homes in towns of less than 2500 population



## OPERATIONS

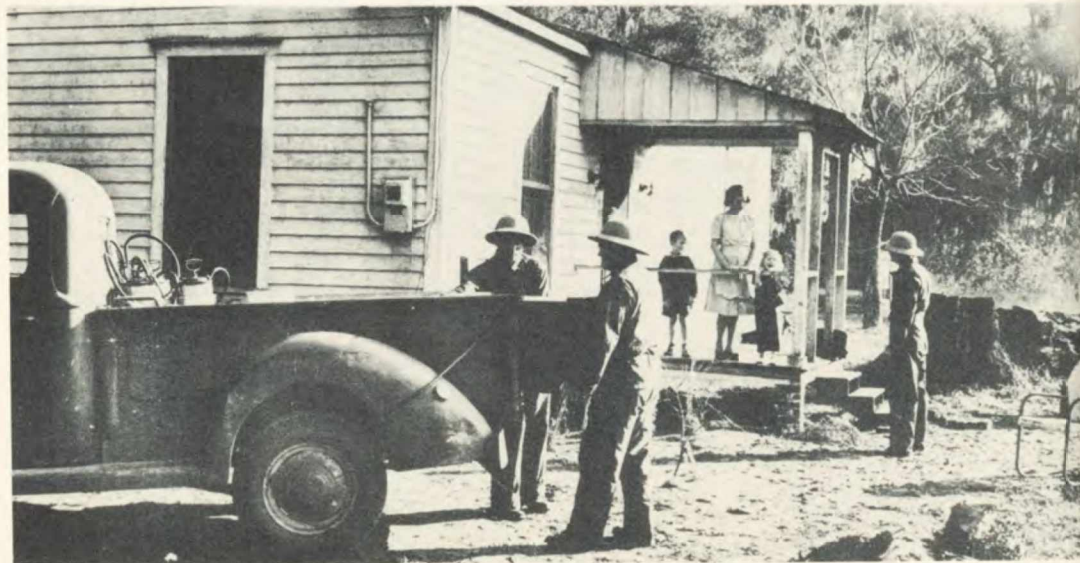
Actually only a fraction of the total number of homes was sprayed before the end of the fiscal year. Spraying began in most States during March and all but one State had started by the middle of April. Because of the delay in supplying equipment and materials to meet the essential requirements of all States, only 300,000 houses had been sprayed through the end of the fiscal year. It is estimated that this represented approximately 27 square miles of potentially lethal resting surface (walls and ceilings) offered to malaria vectors in the worst malarious regions of the country.

The average spraying time per house was 1.35 man-hours. It is expected that this figure will be reduced significantly as operational experience increases. The direct cost per house application including labor and materials averaged \$1.58. The average area sprayed per house was approximately 2,200 square feet. At the recommended application rate of 100 mgs. of DDT per square foot, this represents approximately 8 ounces of DDT per house application.

**EQUIPMENT AND SUPPLY** — A major problem prior to Extended Program operations was obtaining proper equipment in time and in sufficient quantity to meet project requirements. Procurement, specifica-

tions, testing, and modification of equipment were joint responsibilities of the Engineering Division, the Equipment Unit, and the Carter Laboratory at Savannah, Georgia. Numerous types of sprayers, spray nozzles, gaskets, hose, solvents, emulsifiers and other items incidental to DDT residual spraying were tested. Procurement of xylene resistant gasket and hose material was perhaps the most serious difficulty. Of the variety of gasket materials tested, only two were found satisfactory for field use. Three kinds of synthetic rubber hose proved usable. After testing and selecting suitable materials, further delay was experienced in furnishing such large supplies of specialized equipment, due to the failure of various manufacturers to meet delivery schedules. Most of the difficulties were finally overcome so that field crews eventually received all essential equipment.

**PERSONNEL** — Although Extended Program work was conducted during a period of critical manpower shortage, no great difficulties were encountered in hiring personnel. Twelve hundred laborers were employed for the work. Supervision was by area supervisors specially trained or borrowed from the war area program. Inspection of premises was handled by the State Entomologists.



DDT SPRAY CREW. The average spray time was 1.3 man-hours and the cost was \$1.58.



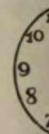
DOSA



RATE OF AP



QUANTITI



modification of responsibilities, the Equipment Laboratory. Numerous types of nozzles, gaskets, mixers and other residual spray equipment of xylene base material was used with difficulty. Various materials tested gave satisfactory results. After testing of synthetic materials, it was found that some materials, when used in furnaces of special design, caused the failure of the equipment to meet delivery requirements. Difficulties were encountered by field crews even when using special equipment. Extended Program. During a period of one year, no great progress was made in hiring laborers who were under supervision was not fully trained or experienced in the program. In some cases, the program was handled by the



as \$1.58.

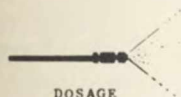
## DDT RESIDUAL SPRAY FORMULAS AND APPLICATION



EMULSION  
CONCENTRATE



SPRAY MIXTURE



DOSAGE



RATE OF APPLICATION



QUANTITIES PER HOUSE



LABOR

### SUMMER FORMULA 35% DDT\*

	POWER MIXER	HAND MIXER
DDT	125 LBS.	84 LBS.
XYLENE	31.5 GALS.	21 GALS.
EMULSIFIER	2 GALS.	5 1/4 QTS.

### WINTER FORMULA 20% DDT\*

	POWER MIXER	HAND MIXER
DDT	70 LBS.	44 LBS.
XYLENE	35 GALS.	22 GALS.
EMULSIFIER	7 QTS.	4 1/2 QTS.

1 PART SUMMER CONCENTRATE

+

13 PARTS OF WATER

=

2 1/4% DDT SPRAY \*

1 PART WINTER CONCENTRATE

+

7 PARTS OF WATER

=

CONTAINING 25 MG. DDT PER CC. SPRAY SOLUTION

100 MG. DDT PER SQUARE FOOT

OR

4 CC. 2 1/4% DDT SPRAY PER SQUARE FOOT

THIS DOSAGE, APPLIED TO WALLS AND CEILINGS, EFFECTIVE 3-5 MONTHS

NOZZLE NO. 4T 8002

80° FAN-SHAPED SPRAY DISCHARGED AT 0.2 GALLONS

OR 757 CC. PER MINUTE AT 40 LBS. PRESSURE.

TO APPLY 4 CC. OF SPRAY AT 100 MG. OF DDT PER SQUARE FOOT, SPRAY AT THE RATE OF 190 SQUARE FEET PER MINUTE.

ONE HOUSE — 1700 SQUARE FEET OF SPRAYED SURFACE — WILL REQUIRE  
AT 100 MG. /SQ. FT. AT 4 CC. /SQ. FT.

170,000 MG.

1 PINT

6800 CC.

OR 170 GRAMS

OF

OR 1.79 GALLONS

OR 6 OUNCES OF DDT

SUMMER CONCENTRATE

2 1/4% DDT SPRAY

1.3 MAN-HOURS PER AVERAGE HOUSE  
WITH HOUSE PREPARED FOR SPRAYING

\*Expressed in percent for simplicity



**TRAINING.** Residual spraying with DDT was an entirely new method of malaria control. Field experience was limited to test projects in Arkansas, Tennessee, Georgia, and Puerto Rico. With only a handful of trained men and the most critical transportation situation in the history of our country, a decentralized training program was set up.

The Carter Laboratory at Savannah, Georgia was the scene of the basic course. Designed for District and State supervisory personnel, this course was conducted as a series of discussions and field demonstrations. The following main subjects were treated in detail during the three-day sessions: operational set-up, decentralized training, lay education, entomological services, principles of residual spraying with DDT, field practice in spraying, hand and power spraying equipment, hand and power mixing of DDT and occupational hazards.

As a result of this course the nucleus of trained men was increased from a dozen to over 75 and each Extended Program State had at least two men with first hand knowledge of the subject.

Decentralized training was then inaugurated. Each State set a date and completed arrangements for a train-

ing course for area supervisors and others charged with immediate responsibility for doing the work. Two mobile training units were equipped with literature, training aids and equipment and were made available to the States. An officer with first hand experience in DDT residual spraying was available to all States that requested assistance in conducting their in-service training program.

Two sorts of training aids were produced for immediate and widespread use. Film strips on "Hand Spraying of DDT," "Power Spraying with DDT," "Mixing of DDT Emulsions," and "Safe Practice in Handling DDT" were prepared in time for the Savannah course and were made available for use throughout the decentralized training program. A "Handbook of DDT Residual Spray Operations" was prepared to give detailed instructions and formulas. Demand for the Handbook has already necessitated a third printing.

Results of the DDT training program can only be measured in terms of smooth working operations. The fact that 1,200 men were put in the field within two months without any evidence of occupational hazards, major public complaints, or operational failure is mute testimony as to the effectiveness of the job.

**TRAINING FOR THE DDT RESIDUAL SPRAY PROGRAM.** With the aid of decentralized training, 1,200 men were put in the field within 2 months without any evidence of occupational hazards, major public complaints, or significant operational difficulties.

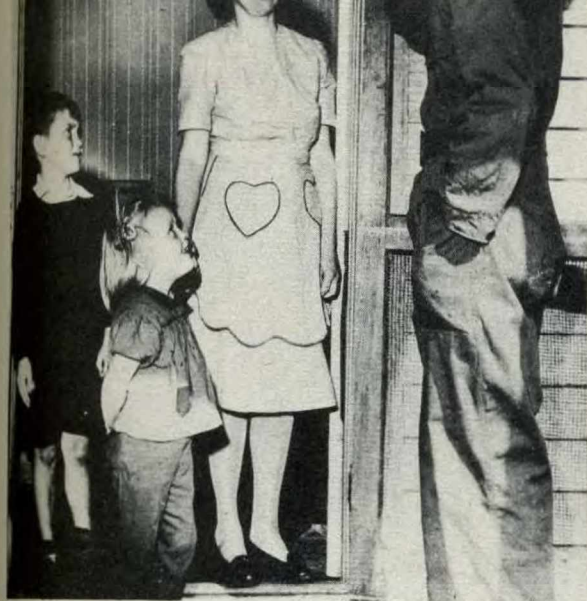


ABOVE:  
ing ho  
arrival  
spray  
enabled  
homes a

PUR  
of the  
in a  
lems  
perso  
princ  
holde  
not e  
coop  
grou  
breed  
ipat  
atio  
sibl  
many  
beer

Pro  
pher  
of  
by





ABOVE: Malaria control assistants contacting householder prior to spray crew's arrival. RIGHT: House being prepared for spraying. Participation by householders enabled crews to spray over twice as many homes as would otherwise have been possible.



**PUBLIC RELATIONS.** Wholesale spraying of the interiors of half a million homes in a free country poses certain problems in public relations. Respect for personal property rights was a basic principle of operations. But the householder's respect or acquiescence was not enough. No less than full, active cooperation was needed to cover the ground in the few months of mosquito breeding. It is estimated that participation by householders in the preparation of homes for spraying made possible the spraying of over twice as many homes as would otherwise have been possible.

The job of selling the Extended Program was made easy because of the phenomenal reputation of DDT. In spite of wartime secrecy and rigid control by the War Production Board, the let-

ters DDT sky-rocketed to national prominence. The demand for DDT and for free household spraying far exceeded the supply of materials and equipment.

In some States malaria education was handled as a part of the general program of health education. In others, public relations problems were handled by malaria control assistants. Many of these "malaria educators" were selected on the basis of their training and experience as teachers. Local residents were chosen upon recommendation of health officers whenever such qualified persons were available. The malaria control assistants were offered two weeks of intensive in-service training and orientation by personnel from Washington and Atlanta and further training and assistance in the field.





SPRAY-TIME



**KNOCKS OUT  
MALARIA  
MOSQUITOES**

*Tom Jones  
Route 2  
Arlington,  
Georgia*

**WE'RE IN THE FIGHT AGAIN**  
This house has been spray



Federal Security Agency, U.S. Public Health Service

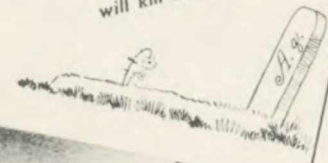
# HOW DDT SPRAY



**KEEPS MALARIA AWAY**



Stay indoors at night  
That is when malaria skeeters bite  
But DDT upon your wall  
will kill them if they call



**SPRAY  
TIME  
TOPIC**

**I'm coming to your house!**






You don't want to be sick with **MALARIA**. Nobody does. That's why your health department wants to spray your house with DDT. DDT kills mosquitoes—mosquitoes that spread **MALARIA**. In the fight against malaria we spray the walls in each room of your house—**THAT'S OUR PART**. Please have your house ready for our spray crew—**THAT'S YOUR PART**.

## Before Spray-Day

Do you plan to clean the walls and ceilings at your house? Then clean them before we use the spray. It will not show. If you wash or paint over the spray, the DDT will not be left to kill mosquitoes.  
It's a good idea to repair screens, walls, floors, and roof. Make it hard for mosquitoes to escape the DDT.

## Spray-Day Musts

-  Pictures and mirrors must be taken off walls.
-  Clothes must be taken out of closets and off walls.
-  Furniture must be moved into middle of rooms.



Food must be covered so the spray will not touch it.  
Pans, dishes, and silverware must be put away where the spray will not reach them.



**ALL FIRES MUST BE PUT OUT**

## If You Wish

Your rugs and mattresses can be sprayed—because DDT kills moths, moth eggs, bed bugs, as well as mosquitoes!



PUBLIC L  
mately 7

Educa  
able from  
material:  
time," sh  
do to pre  
a folder  
ria Away  
ics"; a  
to info  
of the  
radio s  
and play  
Stat  
proximu  
have re  
prevent  
250,00  
have b  
March  
perso  
some m  
in wh  
being  
house  
less  
of lac  
Bu  
story  
ed as  
ed m  
reli  
ness  
numb  
cat  
con



WE'RE IN THE FIGHT AGAINST  
This house has been sprayed



Federal Security Agency, U. S. Public Health

site

**SPRAY  
TIME  
TOPICS**



**PUBLIC LECTURE ON MALARIA PREVENTION AND CONTROL.** State reports indicate that approximately 75,000 persons per month received basic information on malaria prevention.

Educational materials were available from various sources. Among such materials were: a film strip, "Spraytime," showing what the householder can do to prepare his premises for spraying; a folder, "How DDT Spray Keeps Malaria Away"; a leaflet, "Spraytime Topics"; a DDT window sticker; a post card to inform persons of the time of visit of the spray crew; suggested copy for radio spot announcements, interviews, and plays; and sample newspaper releases.

State reports indicate that: 1) approximately 75,000 persons per month have received basic information on the prevention of malaria; 2) approximately 250,000 pieces of printed materials have been distributed per month since March 1945; 3) approximately 500,000 persons have been contacted through some medium each month in the 13 States in which residual spray programs are being operated; 4) of the 300,000 houses contacted up to June 30, 1945, less than 2% were not sprayed because of lack of cooperation of householders.

But statistics are not the whole story. The number of persons contacted and the number of pieces of printed material distributed are no more reliable as criteria of the effectiveness of malaria education than is the number of pounds of DDT as an indication of the efficacy of malaria control. As a matter of fact the re-

sidual effect of the educational program will outlast that of the DDT.

**LAY EDUCATION.** Each individual has a responsibility in malaria prevention. If this responsibility is ignored, either through ignorance or indifference, malaria is likely to persist and even increase as a public health problem, in spite of the efforts of organized agencies. It is fundamentally unsound to continue to do for individuals what they should be able to learn to do for themselves.

Although the immediate objective of the educational work on the MCWA program is to obtain the full cooperation and assistance of the householder in order to facilitate operations, the larger objective of stimulating the public to assume responsibility for malaria prevention must be kept in mind. The range of individual activities may extend from repairing screens to cheerfully contributing money for the development of permanent malaria control or mosquito abatement projects in communities throughout the country. Furthermore this work should be seen in its true light, as part of a general health program including improved nutrition, general sanitation and medical care. This, in turn, influences and is influenced by general economic and sociologic conditions at home and throughout the world.





Sample inspections are made after spraying to determine the presence of live anophelines. Unsprayed favorable adjacent resting places are also inspected to judge the effectiveness of the spray.

### ENTOMOLOGICAL EVALUATION

Because of the low malaria rates prevailing in this country at present and the errors of the known methods of measurement during this low ebb of the disease, the effectiveness of the residual spray program is determined by entomological data. Random inspections of a number of premises on each control project are made at monthly intervals after the start of spraying to determine if any live anophelines are present. Also, the number of anophelines found in an unsprayed favorable adjacent resting place such as a barn or stable is determined so that the effectiveness of the spray can be judged

Precipitin tests of engorged female anophelines are made at the Savannah laboratory. 2955 specimens from unsprayed areas gave a human blood feeding rate of 4.8 percent, while 1090 specimens from sprayed areas gave a human blood rate of 1.3 percent.



in areas having various densities. From these places, engorged females are collected and forwarded to the Savannah laboratory where precipitin tests are made to determine the percentage of specimens which have had human blood meals. If the residual spray is effective, the percentage of mosquitoes positive for human blood should be less than the 4% normally found.

By the end of the fiscal year, inspections had been reported from 45 areas in 9 States. In these areas a total of 2,469 sprayed houses had been inspected, in only 60 of which anophelines were found late in the day, although 160 had them present at the morning inspections. On 40 percent of these premises over 10 anophelines were counted in outside resting places and on an additional 21 percent outside resting place counts of from 1 to 10 were found.

From 27 areas in 6 States a total of 4,082 specimens had been sent in for precipitin tests. 2,955 specimens from unsprayed areas gave a human blood feeding rate of 4.8 percent, while 1,090 specimens from sprayed areas gave a human blood rate of 1.3 percent. Of even greater significance 425 mosquitoes collected inside unsprayed houses showed 30.6 percent positive for human blood whereas all 22 mosquitoes caught inside sprayed houses were negative for human blood.

MOBILE UNIT.

2 or 4 seasons

M

The prob

carriers i

States is a

vectors occ

side resting place counts of from 1

States, fa

of the dis

malaria ve

presents a

found. Furt

have occur

after prev

and elsewh

From th

the probl

question o

tence of a

the South

the persi

versely, t

ease in r

States an

northern

vectors, r

Consequen

been conc

rious are

outfitted

Each r

engineer

crew of t

Equipment

a truck

ratus an

larvicidi

drainage



various densities. engorged females forwarded to the where precipitin determine the per- ens which have had . If the residual e, the percentage ive for human blood n the 4% normally

the fiscal year, in- reported from 45

In these areas a yed houses had been 60 of which anoph- late in the day, em present at the s. On 40 percent ver 10 anophelines ide resting places l 21 percent out- counts of from 1

6 States a total dbeen sent in for 55 specimens from e a human blood 8 percent, while sprayed areas gave of 1.3 percent. ficance 425 mos- inside unsprayed ercent positive eas all 22 mos- sprayed houses an blood.

annah laboratory. of 4.8 percent, 3 percent.



**MOBILE UNIT.** Each unit is directed by an engineer or entomologist with a labor crew of 2 or 4 seasonal employees. Last year, 12 units were in operation in 15 States.

### MARGINAL STATES

The problem of returning malaria carriers in the so-called marginal States is a difficult one. Efficient vectors occur in enormous numbers in some sections of the northern tier of States, far from the endemic centers of the disease. The co-existence of malaria vectors and malaria carriers presents a very real hazard, wherever found. Furthermore, sporadic epidemics have occurred under such conditions after previous wars in this country and elsewhere.

From the standpoint of operations the problem resolves itself into a question of degree of hazard. The existence of a hazard in endemic areas in the Southeastern States is proved by the persistence of the disease. Conversely, the disappearance of the disease in recent years in the marginal States and its total absence from the northern limits of distribution of the vectors, prove that the hazard is less. Consequently, routine operations have been concentrated in the endemic malarious areas and mobile units have been outfitted to cover marginal States.

Each mobile unit is directed by an engineer or entomologist with a labor crew of two to four seasonal employees. Equipment includes a station wagon and a truck outfitted with standard apparatus and materials for inspection, larviciding, spraying for adults, minor drainage and drainage maintenance.

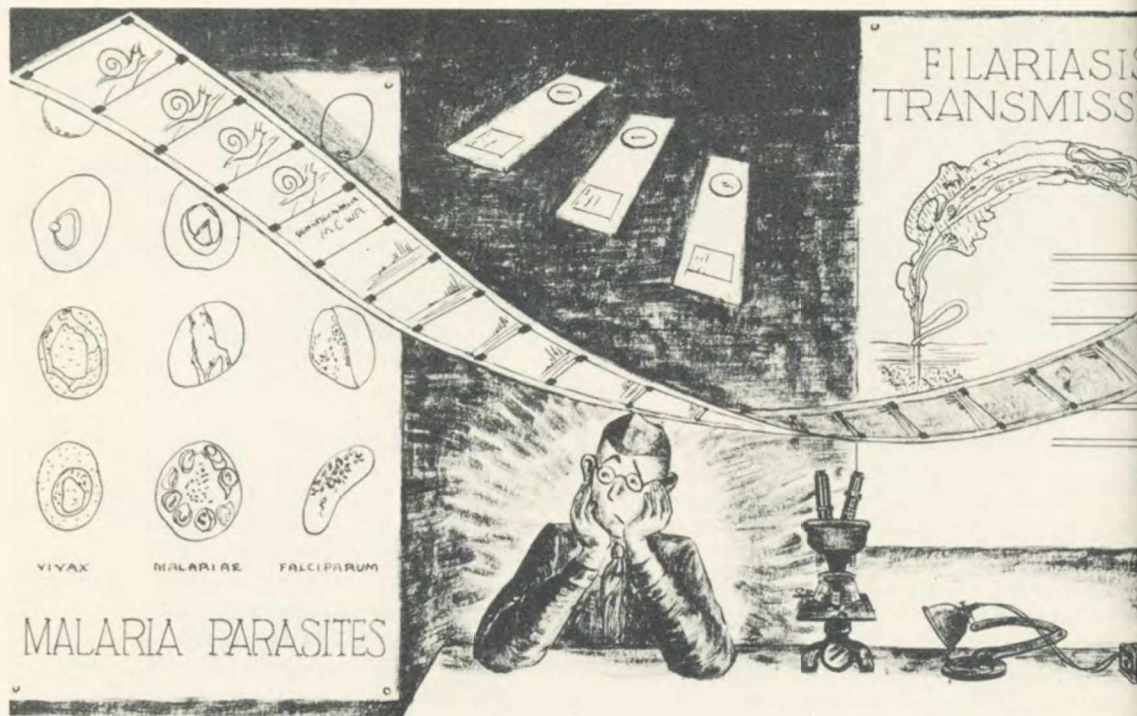
Mobile units are assigned to Public Health Service District Offices and operate in cooperation with health departments of the various States. Operations include (1) surveillance and inspection services where needed, (2) training of local crews in control measures, and (3) actual control around military installations where resident MCWA projects do not exist and malaria mosquito breeding is significant.

In the event of a malaria outbreak mobile units can be dispatched to the area immediately to start control operations. Later, if needed, a resident project may be set up or personnel and equipment may be transferred from the nearest regular project.

Mobile residual spraying units are coming into use for spot malaria control of premises where presence of the disease has been verified by a positive blood smear. This promises to be the answer to the returning carrier problem outside of the endemic Extended Program areas. In some States the premises are sprayed wherever a case of malaria is proved by blood examination or, in the case of an ex-service man, by positive evidence of recent history of the disease.

During the fiscal year 12 mobile units were in operation to serve 15 States. Control was carried out in 10 areas. Surveillance or inspectional services were rendered in 63 zones.





## TRAINING PROGRAM

Training activities form an integral part of the malaria control program. As the control program expanded to take on new responsibilities, the scope of the training activities increased. During the past year the work included the formal pre-service orientation course and the in-service training course for operations personnel, the preparation and distribution of monthly field bulletins, entomological and engineering field handbooks, bulletins, pictorial keys, posters, displays, newspaper and radio releases, training and educational film strips and motion pictures, photographs, and lantern slides.

### IN-SERVICE TRAINING PROGRAM

The need for orientation and train-

ing became evident early in the malaria control program. With the great demand for specialized personnel it became increasingly difficult to find individuals with training and experience in malaria control. Therefore it was necessary to introduce specific training for the professional personnel recruited to carry on the engineering and entomological phases of the program.

The In-Service Training and Orientation Course as conducted during the past year includes a brief account of U. S. Public Health Service and MCWA activities, with instruction in military regulations for commissioned officers. Technical training involves entomological, engineering, medical and administrative aspects of malaria control and limited study of *Aedes aegypti* control.

Training in  
quito identifi  
nd habits, s  
nspection at  
ntomologica  
pects of th  
ng, mapping  
DT residual  
ures. Medic  
s follows:  
f malaria p  
nd clinical  
ent of mala  
ration incl  
olls, person  
olies, prop  
ouchers.

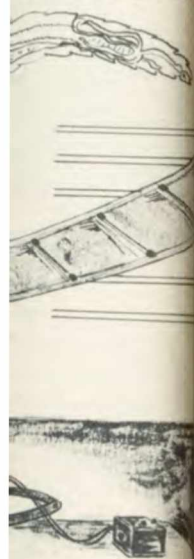
Mosquito  
tion make up  
laboratory  
perience is  
stration and  
In the field  
portunity to  
in collecti  
toes, settin  
tions, surve  
project. In  
an opportun  
effectivene

Followin  
students vi  
tion near  
supervisor  
in various

FIELD TRAIN  
ing and ide  
mapping a c



# MARIASIS SMISSION



1

the malaria  
reat demand  
it became  
find indi-  
experience  
fore it was  
fic training  
el recruit-  
eering and  
program.  
and Orienta-  
ng the past  
nt of U. S.  
CWA activi-  
itary regu-  
officers.  
entomolog-  
nd adminis-  
control and  
ti control.

Training in entomology covers mos-  
quito identification, anopheline ecology  
and habits, station establishments and  
inspection and the interpretation of  
entomological data. The engineering  
aspects of the course include survey-  
ing, mapping, larviciding, drainage,  
DDT residual spraying and control mea-  
sures. Medical subjects are discussed  
as follows: epidemiology, life cycle  
of malaria parasites, microscopical  
and clinical diagnosis as well as treat-  
ment of malaria. Training in adminis-  
tration includes consideration of pay  
rolls, personnel, procurement and sup-  
plies, property records and travel  
vouchers.

Mosquito and parasite identifica-  
tion make up the major portion of the  
laboratory work, and practical ex-  
perience is gained in a field demon-  
stration and training area near Atlanta.  
In the field the students have an op-  
portunity to obtain first-hand experience  
in collecting and identifying mosqui-  
toes, setting up adult and larval sta-  
tions, surveying and mapping a control  
project. In this area they also have  
an opportunity to apply and check the  
effectiveness of larvicides.

Following this field experience the  
students visit an area of actual opera-  
tion near Valdosta, Georgia. Under  
supervision, the students participate  
in various control activities. These

**FIELD TRAINING.** Students have an opportunity to obtain first-hand experience in collect-  
ing and identifying mosquitoes, setting up adult and larval stations, surveying and  
mapping a control project.

may range from administrative proce-  
dures to the application of larvicides  
or digging a ditch. At the Carter Memo-  
rial Laboratory in Savannah, Georgia,  
trainees are given experience on the  
*Aedes aegypti* control project and in  
the use of DDT as an insecticide.

Recently the course has been broad-  
ened to include other arthropod-borne  
diseases. Since some members of the  
MCWA staff have had months or years of  
experience in various theatres of mili-  
tary operations, trainees are given  
the benefit of discussions on the con-  
trol of malaria and other tropical  
diseases in the China-Burma-India,  
Pacific, Middle East, European, and  
American theatres.

The complete course requires from  
two to three weeks, depending upon the  
experience of the trainee enrolled.  
During the past fiscal year officers  
and civil service employees totaling  
81 have completed the course. Of these,  
48 were engineers, 7 entomologists,  
2 were medical doctors, and 24 were  
specialists in various other profes-  
sions. Special short courses of a week's  
duration were given to 10 State Health  
Department employees and to 72 MCWA  
clerical employees. Visitors to the  
course numbered 138 including repre-  
sentatives from state health depart-  
ments, UNRRA, the Army and Navy, various  
universities and foreign countries.







MOTION PICTURE CREW. 22 motion pictures were started or released last year.

### VISUAL AIDS

With only a few exceptions, the audio-visual materials available on malaria at the beginning of our program were found to be inadequate and out of date. Such materials were needed urgently in order to conserve the time of teaching personnel and to increase the effectiveness and intensity of the training program. It was therefore necessary to develop facilities for the production of motion pictures, film strips, and other visual materials for use in headquarters training and in the States. Units have now been prepared covering the following subjects: entomological field surveys, mosquito identification, mosquito proofing, oil and paris green larvi-



ART UNIT. The work of this unit includes: original layouts, titles, sketches and retouching of photographs.

ciding, permanent ditch lining, the use of dynamite in anti-malaria drainage, and the mixing and application of DDT emulsions. Technical and popular units in English and Spanish have been produced on *Aedes aegypti* control.

During the fiscal year three motion pictures were released, 14 were started, and 5 were brought practically to completion. Documentary film covering all phases of MCWA reached the imposing total of 10,000 feet in unedited form. In addition to a general documentary film sufficient footage is now available for the production of 15 short units on special phases of the program. These will include four or five beautiful units covering each step from inauguration to dedication in the preparation of a reservoir base upon sound malaria control principles.

Substantial progress was also made in the development of a film strip series. Most of the film strips released during the year were emergency orders to meet the needs of immediate operations. But several of the 80-odd separate subjects in the proposed malaria film strip series were also completed.

In addition to its main projects the Training Aids Section received numerous special requests for services from Headquarters personnel and from field personnel. Photographers took 3,944 photographs and the photographic laboratory made 12,524 prints, 1,223 — 3 1/4" x 4" slides and 1,335 — 2" x 2" slides. The art unit, in three months of its activity, completed 28 original layouts, 52 titles, 24 sketches, and 133 retouched photographs.

Special mention is made of these training materials in order to stimulate wider interest in their development and utilization. These and other materials are available upon request for use by state and local health departments and by universities and medical schools. Production memoranda on each of these have been sent to Public Health Service District Offices and to state health officers.

LECTURE IN  
LABORATORY (comprehensive training offered to personnel in diagnosis of malaria)



### PROFESSIONAL

It has been recognized that malaria is man-made, is man-made neglect of the general public concerned with ways and means. No less is the neglect of the profession of malaria diagnosis and reporting. Over the slightly and a little or malaria and

Ignorance of the war condition



ch lining, the  
-malaria drain-  
nd application  
nical and pop-  
h and Spanish  
*Aedes aegypti*

r three motion  
14 were start-  
practically to  
film covering  
ed the impos-  
t in unedited  
general docu-  
footage is now  
uction of 15  
phases of the  
lude four or  
covering each  
o dedication  
servoir based  
principles.

was also made  
a film strip  
rips released  
gency orders  
mediate opera-  
80-odd sep-  
posed malaria  
o completed.

projects the  
eived numer-  
services from  
d from field  
took 3,944  
graphic lab-  
ts, 1,223 —  
5 — 2" x 2"  
three months  
28 original  
etches, and

de of these  
r to stimu-  
development  
other mater-  
est for use  
departments  
al schools.  
ch of these  
1th Service  
ate health

LECTURE IN TROPICAL DISEASE  
LABORATORY (Below). A compre-  
hensive training course is  
offered to health department  
personnel in the laboratory  
diagnosis of parasitic diseases.



### PROFESSIONAL RELATIONS

It has been stated that all malaria is man-tolerated and most malaria is man-made. This reflects a general neglect of the subject, not only by the general public but by those concerned with the construction of highways and various types of impoundments. No less important in this respect is the neglect on the part of the medical profession of adequate technics of malaria diagnosis and reliable case reporting. Most medical schools pass over the subject of malaria rather lightly and hospital staffs devote little or no time to discussions on malaria and other parasitic diseases.

Ignorance and neglect of these matters is all the more important under war conditions with millions of Ameri-



SCRIPT PLANNING. A conference is held to work out details of production.

cans returning and upsetting the existing balance in this country. Malaria is of greatest concern but other tropical diseases are involved. Practitioners throughout the land will be confronted with cases of filariasis, schistosomiasis, leishmaniasis and other exotic diseases during the immediate postwar period. Furthermore, tropical diseases will continue to crop up as implications and responsibilities of the new Air Age become apparent.

Since ignorance and neglect are the basic causes of the present situation, enlightenment and aggressive action may be prescribed as a cure. Accordingly a comprehensive program is planned for the production of training aids and for the distribution of these and other materials and specimens to schools of medicine, engineering and parasitology. Technical materials are available for medical societies and general information is available to interested parties upon request.





## Aedes Aegypti Program

The key-note of the *Aedes aegypti* control program for the fiscal year was integration of inspection and control activities with city sanitation programs. The transition from a strictly war emergency program to an integral part of local sanitation activities has been gradual but inevitable. In their house-to-house search for *aegypti* breeding places, inspectors encountered many insanitary conditions which they had no authority to remedy. Some of these, such as leaking sewers, accumulations of garbage and rat harbourages, were of greater immediate concern than the mosquito breeding places. Such conditions were commonly referred to general sanitary inspectors but the duplication of effort was wasteful and unnecessary. Hence the emergence of the concept of house-to-house sanitary inspection which, in effect, means carrying public health down to the individual.

In actual operation, the integration program is a joint effort of MCWA and various city health departments,

carried on in cooperation with State health departments. At least half of the crew is on the city pay roll. A month's course in general sanitation was arranged within participating local health departments.

A sanitary survey was undertaken in each participating city, in order to determine the nature and extent of the existing problems. Records were kept as to: 1) premises inspected, 2) premises breeding mosquitoes, 3) containers, 4) sewage disposal, 5) general sanitation, 6) garbage disposal, and 7) rats.

During the fiscal year integration programs were started in the following cities: Charleston, S.C.; Savannah, Ga.; New Orleans, La.; Houston and San Antonio, Texas. The program was such a success that one city surpassed its original commitment of matching Federal employees, man for man, and took over the most experienced and reliable men on a permanent basis. In this way the city built up a very efficient group of sanitary inspectors.



### SUMMARY OF ACTIVITIES

A summary of activities is given for 1944 with data for the previous two years included as a comparison. The total number of inspections in the continental United States for 1944 was 1,231,146, with *Aedes aegypti* breeding appearing in 53,156 of these. The breeding index, or percentage of total premises inspected where breeding was found, decreased from 8.7 in 1942 to 5.3 in 1943 and 4.3 in 1944.

Key West, Florida started with a high index of 13.2 in 1942. This was reduced by an all out campaign to 3.3 for the year 1943. At one point during the year the index reached a fraction of 1 percent but complete eradication was never achieved. In 1944 the attempt at eradication was abandoned because of the greater need for protection in

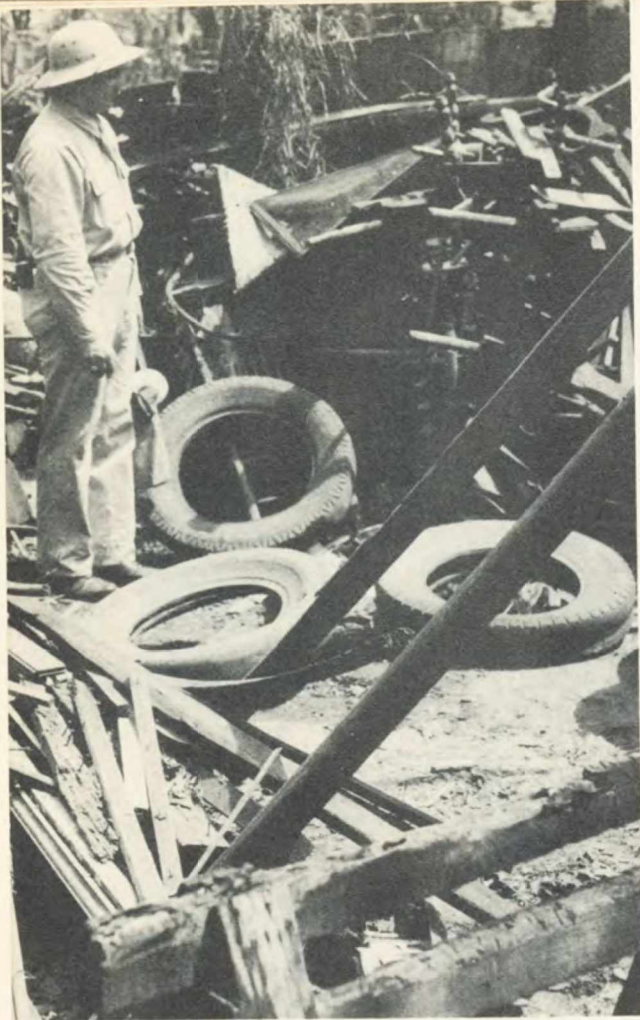
other critical areas in the Southern States. With a decrease in personnel in 1944 the index climbed back to 10.1.

Miami is the largest airport of entry and consequently a large proportion of the total *Aedes aegypti* effort was concentrated there. The city of Miami maintained an anti-mosquito project for a number of years before the war and many of the techniques now used throughout the program were patterned after Miami procedures. The Miami procedures in turn were based on experiences of the Rockefeller Foundation in Brazil. The 1942 index of 5.85 was low because of a backlog of seven years' previous work. This work was intensified under our wartime program and the 1944 index shows a satisfactory decrease to 3.7.

TABLE II  
*Aedes aegypti* Summary

PROJECT	PREMISES INSPECTED			INDEX		
	1942	1943	1944	1942	1943	1944
Key West, Fla.	43,411	68,871	29,218	13.2	3.3	10.1
Miami, Fla.	216,373	523,173	383,344	5.8	7.8	3.7
Savannah, Ga.		55,150	76,201		21.8	3.1
New Orleans, La.		118,971	92,409		7.7	6.0
Charleston, S. C.	60,608	194,456	66,834	3.3	1.8	2.5
Brownsville, Tex.	96,500	224,022	75,809	10.9	5.5	1.4
Corpus Christi, Tex.	58,903	169,945	86,936	9.2	0.9	0.9
Houston, Tex.	152,924	447,421	147,136	9.7	4.6	2.8
Galveston, Tex.	59,247	144,364	48,880	1.5	1.4	1.3
Hidalgo Co., Tex.	3,100	33,166	54,937	8.1	4.6	2.0
San Antonio, Tex.		14,436	55,837		10.4	5.4
Laredo, Tex.			3,971			.2
Mobile, Ala.			69,946			10.3
Tampa, Fla.			22,606			2.2
Jacksonville, Fla.			17,682			2.0
TOTALS	691,066	2,023,893	1,231,246	8.7	5.3	4.3





**SANITARY INSPECTION.** (Left) A sanitary survey was undertaken in each participating city in order to determine the nature and extent of the existing problems. **GARBAGE AND SANITARY COLLECTION.** (Right) Inspectors reported accumulations of trash including mosquito breeding places to the Department of Public Works.

The Charleston project also had a backlog of a number of years of intensified work by the city. Consequently the first wartime year showed a greatly reduced index of 3.3. This index was reduced slightly in the following years and actual mosquito breeding has probably been reduced even more because of the increased efficiency in inspection with the added experience of the crew.

The Savannah and New Orleans projects were started as mobile units in 1943. In the case of Savannah an attempt was made to cover the city as thoroughly as possible and satisfactory reduction was achieved in one

year. New Orleans on the other hand, because of its large size, was not covered exhaustively. Hence, the index of 7.7 might be deceptively low.

The Texas projects followed a uniform pattern of high initial index and progressively lower indices in succeeding years. Success was achieved in these instances by concentration on "mother foci" early in the program, by an all-out educational campaign and by a gradual intensification of routine inspections.

No generalizations are warranted in the case of Mobile, Tampa, and Jacksonville because of the short period of operation of these projects.

DE  
IN THE

Last year  
ague had been  
the Territor  
July 1943 the  
total of 159 c  
in October.  
year the inc  
average of le  
The total n  
during the ep  
were reporte  
ember of 19  
four months

Dengue fi  
and June of  
reported. I  
resulted fr  
since the d  
the Southwes  
up of these  
nise sprayi  
to avoid ano

Routine c  
cal year inc  
spections o  
to be breed  
more abunda  
albopictus.

cluded rem  
debris and  
campaign t  
hole breedi  
and 5,343 r

Control of A  
with DDT and



## DENGUE CONTROL IN THE TERRITORY OF HAWAII

Last year it was reported that dengue had been all but eliminated from the Territory of Hawaii. Starting in July 1943 the epidemic built up to a total of 159 cases during the third week in October. By the end of the fiscal year the incidence had subsided to an average of less than one case per week. The total number of cases reported during the epidemic was 1,506. No cases were reported during November and December of 1944 and during the first four months of 1945.

Dengue flared up anew during May and June of this year with 10 cases reported. It is assumed that these resulted from a new introduction, since the disease is widespread in the Southwest Pacific. In the follow-up of these new cases, complete premise spraying was done in an effort to avoid another widespread epidemic.

Routine operations during the fiscal year included 922,788 premise inspections of which 11,238 were found to be breeding *Aedes aegypti* or the more abundant Hawaiian species, *Aedes albopictus*. Clean-up activities included removal of 661 truckloads of debris and breeding containers. In the campaign to eliminate tree and rock hole breeding places 17,325 tree holes and 5,343 rock holes were filled.

Control of *Aedes* Breeding Places in Hawaii with DDT and by general clean-up activities.



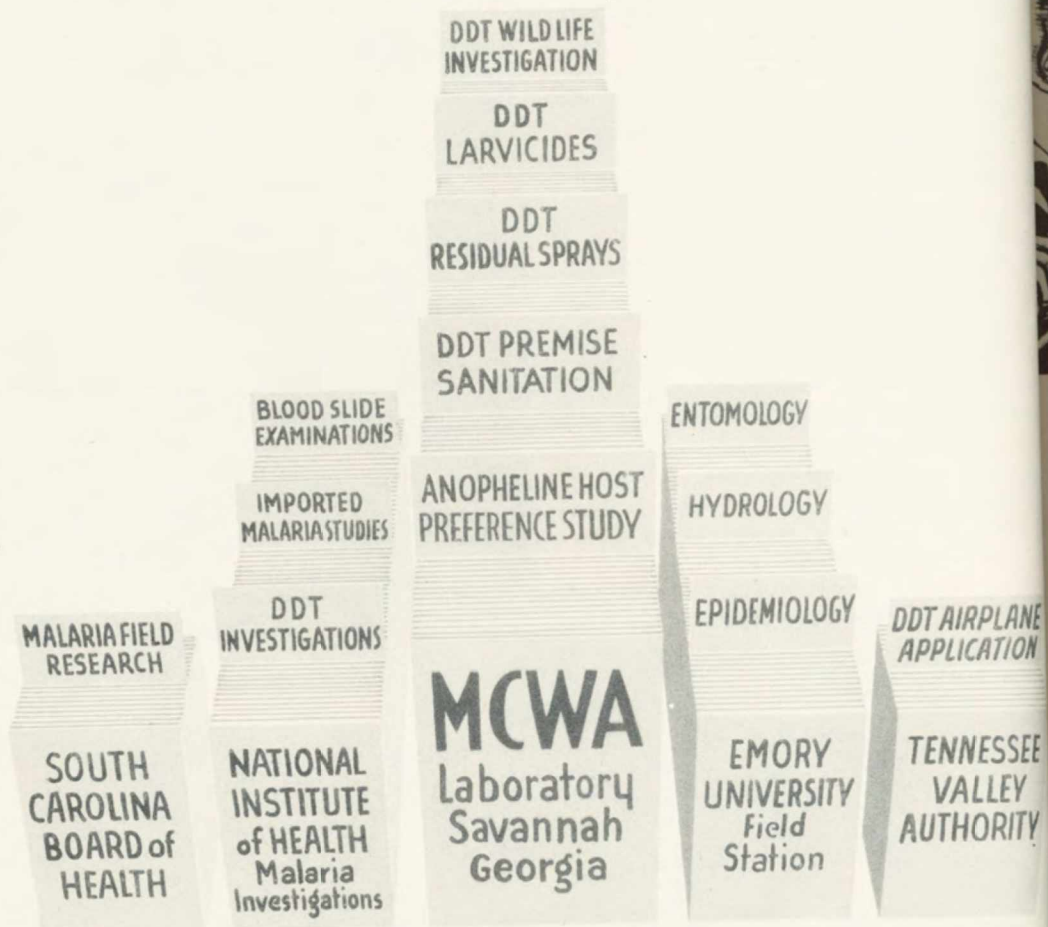
participating city,  
garbage and sanitary  
mosquito breeding

the other hand,  
size, was not  
Hence, the in-  
ceptively low.  
followed a uni-  
tial index and  
ces in succeed-  
chieved in these  
ion on "mother  
am, by an all-  
and by a grad-  
f routine in-

re warranted in  
opa, and Jack-  
short period  
projects.



# INVESTIGATIONAL PROGRAM



# NAL



## Malaria Control in War Areas, Investigational Projects

DDT AIRPLANE  
APPLICATION

TENNESSEE  
VALLEY  
AUTHORITY

The scientific discoveries stimulated by World War II probably surpass those of any equivalent period in the history of mankind. Advancements in the field of malariology have been especially noteworthy. But a tremendous gap exists between pure scientific knowledge and practical control. To bridge this gap for MCWA operations, a program of technical development was inaugurated.

Investigations were centered around the problem of the returning malaria carrier and the possibility of using

DDT to meet the threat of local epidemics or a general resurgence of the disease. Invaluable assistance was rendered in the investigational program by the National Institute of Health, the Health and Safety Division of the Tennessee Valley Authority, the Bureau of Entomology and Plant Quarantine, Emory University, the various State Health Departments, and others. MCWA acted as a participating agency in the over-all wartime program of the Office of Scientific Research and Development.



# IMPORTED MALARIA STUDIES COLUMBIA, S. C., LABORATORY, NIH

At the start, it was necessary to test the basic assumption that introduction of foreign malarias would constitute a hazard to residents of the continental United States. To determine the public health significance of the returning malaria carrier, an investi-

*falciparum* and the rest were *Plasmodium vivax*. These infections originated in Guadalcanal (94), New Guinea (61), other South Pacific islands (24), Mediterranean (41), Caribbean (6), Burma (1), and Liberia (1).

To carry out the infectivity experi-

TABLE III  
Imported Malaria Studies  
Total Number of Mosquitoes Reared, Fed, Dissected and Infected

SPECIES OF ANOPHELES	REARED PUPAE	APPLIED	FED	DISSECTED	% INFECTED
1. quadrimaculatus..	982,613	36,422	30,650	10,109	41.1
2. freeborni.....	164,835	16,169	12,787	4,088	46.1
3. albimanus.....	13,014	1,065	645	425	1.4
4. punctipennis.....	5,294	406	171	139	50.4
5. pseudopunctipennis	1,075	160	81	61	24.6
6. franciscanus.....	530	88	37	23	52.2
7. occidentalis.....	2,200	285	138	59	61.0
8. walkeri.....	3,731	120	25	16	0.0
TOTAL .....	1,173,292	54,715	44,534	14,920	41.4

gational program was set up in cooperation with the National Institute of Health and the U. S. Army.

Four laboratories were operated during the program as follows: Headquarters — the National Institute of Health Malaria Investigations laboratory at the South Carolina State Hospital, Columbia, S.C.; Letterman General Hospital, San Francisco, Calif.; Harmon General Hospital, Longview, Texas; and Moore General Hospital, Swannanoa, N.C. These laboratories had access to troops in about twelve Army and Navy hospitals and secured the cooperation of six mental hospitals for further study of malaria infections.

Relapsing malaria infections of foreign origin were studied in 228 soldiers. Three of these infections were *Plasmodium*

ments, colonies of various species of United States anophelines were established and maintained in insectaries. More than one million mosquitoes were handled of which over 44 thousand were fed on malarious patients. A total of 41.4 percent of these mosquitoes became infected.

The total numbers of mosquitoes reared, fed, dissected, and infected is shown in the table above. The species are listed in the order of their importance as vectors of malaria in this country, based upon epidemiological evidence.

To test the infectivity of these mosquitoes, 246 attempts were made to induce 55 different infections in neurosyphilitic patients. 67.1 percent of these attempts were successful.

In the course of the study, it was found that the mosquitoes fed themselves the following factors: 2) Success:

vectors did not show virulence; 3) these foreign mosquitoes from previous infections; 4) The foreign mosquitoes as a result of infection for the foreign strains distributed.

In conclusion, Foreign malaria troops can be controlled; 2) The foreign malaria if not great number of cases; control measure foreign malaria.

FOREIGN MALARIA  
Mosquitoes  
sporozoite  
Mosquitoes



# DIES

## Y, NIH

rest were *Plasmodium*  
tions originated in  
w Guinea (61), other  
(24), Mediterranean  
(5), Burma (1), and

infectivity experi-

d Infected

ECTED	% INFECTED
109	41.1
088	46.1
425	1.4
139	50.4
61	24.6
23	52.2
59	61.0
16	0.0
920	41.4

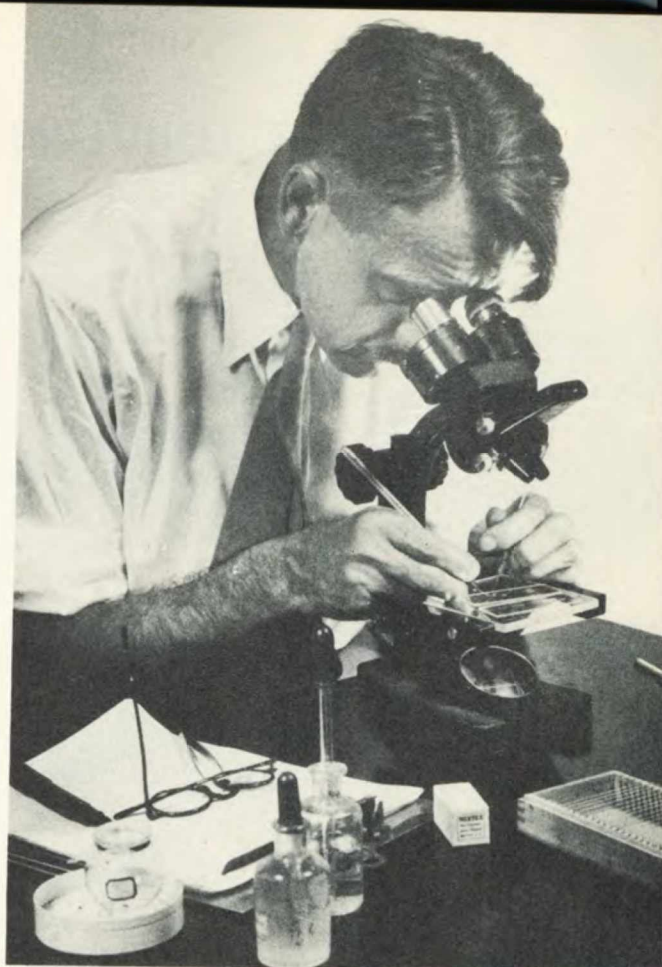
arious species of  
ines were estab-  
l in insectaries.  
mosquitoes were  
44 thousand were  
ents. A total of  
mosquitoes became

mosquitoes reared,  
ected is shown in  
ecies are listed  
importance as  
this country,  
cal evidence.  
ivity of these  
ts were made to  
ctions in neuro-  
7.1 percent of  
cessful.

In the course of the investigations it was found that: 1) Foreign malarias adapted themselves readily to our insect vectors; 2) Successive transfers through our vectors did not result in a decrease in virulence; 3) Little immunity against these foreign infections resulted from previous infections with native malarias; 4) The foreign malarias were infective to mosquitoes as long as relapses occurred — hence some troops may be sources of infection for several years; 5) Some of the foreign infections seemed to be strains distinct from native malarias.

In conclusion it may be said that: 1) Foreign malarias relapsing in returning troops can be spread by our native vectors; 2) The public health hazard of the foreign malarias seems to be as great, if not greater, than with a similar number of cases of native malarias; 3) Control measures are necessary against these foreign malarias in returning carriers.

FOREIGN MALARIA INVESTIGATIONS. (Right) Mosquitoes are dissected to determine sporozoite and oocyst infection. (Below) Mosquitoes are fed on volunteer's arm.





# EMORY UNIVERSITY FIELD STATION

Closely connected with the problem of the returning malaria carrier is the present status of malaria in the United States. The most fundamental questions in malariology in the continental United States remain unanswered to this day. Is malaria a disease of cycles? If so, what became of the last scheduled resurgence of the disease? Where does malaria go in periods of remission?

In an effort to answer these and other basic questions, a field station was established by Emory University in an endemic malarious area in Southwest Georgia in 1939. The approach was unique — involving an intensive study of practically every phase of naturally occurring malaria over a long period of time. The program was outlined to measure systematically the occurrence of malaria and as many attendant biological and physical factors as possible in the same area.

MCWA has cooperated in this enterprise together with the Georgia Department of Public Health and the U. S. Geological Survey, because of the importance of the work and because of the need for accumulated data of a number of years upon which to base current investigations. For example, it is hoped to test the effect of DDT residual sprays on a known population of mosquitoes as soon as vector counts

become high enough to insure that the results will be statistically significant.

Basic observations at the Field Station are of three general types:

1. Those pertaining to the measurement of malaria in man. (Epidemiology)
2. Those concerned with determination of mosquito densities, both larval and adult. (Entomology)
3. The measurement of hydrological and meteorological factors related to the occurrence of malaria. (Hydrology)

## INVESTIGATIONS OF MALARIA IN MAN.

An intensive study has been conducted since 1939 of a group of about 1,000 persons. Weekly or biweekly visits are made by nurses and a careful clinical history is kept of each individual. Thick and thin blood films are collected if any symptoms of malaria are noted. Persons are encouraged not to take anti-malarial drugs because of the danger of obscuring laboratory diagnoses. A complete course of treatment is given if the blood smear is positive.

Under these favorable circumstances, and in the absence of any control measures, it is interesting to note that malaria declined in the Experimental Area just as it did in other parts of the country.

COLLECTING METEOROLOGICAL DATA. (Left) Hydrological and meteorological factors related to the occurrence of malaria are measured at the Field Station. MORBIDITY SURVEY. (Right) Weekly and bi-weekly visits are made by nurses and clinical histories kept of all cases.



BIOLOGICAL  
density depen  
factors, both  
strictly biol  
during the p  
routine larv  
The little  
during the wi  
a view toward  
during this  
are extreme  
and consist  
in such pla  
The probl  
mosquitoes  
efficiency  
cant progr  
marking mos  
Fluorescent  
abic and du  
quitoes. Me  
at various  
release. M  
readily by  
violet li  
HYDROL  
logical c  
the Field  
flow by s  
ter level  
at 8 stat  
ture and  
ponds wer  
level rec  
ers, rec  
banks aw  
water,  
corder  
ENTO  
FECTION  
data a  
Area si  
evalua  
the res  
imenta  
format  
may se  
mosqu  
rural  
be und  
indic  
resul



# TION

to insure that the  
ically significant.  
t the Field Station  
types:

to the measurement  
(epidemiology)  
with determina-  
ties, both larval  
(y)  
of hydrological  
rs related to the  
(Hydrology)

LARIA IN MAN. An  
conducted since  
t 1,000 persons.  
its are made by  
nical history is  
Thick and thin  
ed if any symp-  
ed. Persons are  
anti-malarial  
er of obscuring  
complete course  
the blood smear

circumstances  
control meas-  
note that ma-  
erimental Area  
parts of the

ors related to  
SURVEY. (Right)  
of all cases.

**BIOLOGICAL INVESTIGATIONS.** Anopheles density depends upon a number of complex factors, both biotic and physical. Two strictly biological problems were studied during the past season in addition to routine larval and adult counts.

The little known habits of Anophelines during the winter months were studied with a view toward the possibility of control during this critical period. Populations are extremely low at this time of year and consist of females in semi-hibernation in such places as hollow trees.

The problem of dispersal of Anopheles mosquitoes is closely related to their efficiency as disease vectors. Significant progress was made in methods of marking mosquitoes for dispersal studies. Fluorescent dusts were mixed with gum arabic and dusted on large numbers of mosquitoes. Mosquitoes were collected later at various distances from the point of release. Marked specimens were detected readily by passing them under an ultra-violet light.

**HYDROLOGICAL INVESTIGATIONS.** Hydrological conditions were determined for the Field Station area as follows: stream flow by seven gaging stations; ground water level by 90 observation wells; rainfall at 8 stations; and atmospheric temperature and humidity at 3 stations. Fifteen ponds were equipped with continuous water level recorders, water temperature recorders, recording rain gauges and, on the banks away from the influence of the pond water, temperature and humidity recorders.

**ENTOMOLOGICAL EVALUATION OF THE EFFECTIVENESS OF DDT RESIDUAL SPRAYS.** The data accumulated in the Experimental Area since 1939 provide a sound basis for evaluating the entomological phases of the residual spray program. In the Experimental Area there is a backlog of information on mosquito densities which may serve as a basis for comparison of mosquito densities after treatment of rural houses with DDT. The project will be undertaken as soon as mosquito counts indicate that statistically significant results can be obtained.



ABOVE: Winter collecting of "Quads" by fumigation of a hollow tree.



ABOVE: Collecting mosquitoes in red box.  
BELOW: Limnological investigations.





# CARTER MEMORIAL LABORATORY SAVANNAH, GEORGIA

Having determined that a hazard exists in connection with the return of malaria carriers from military service, it was necessary to develop methods of meeting the problem. This is being done at the Carter Memorial Laboratory at Savannah, Georgia. Activities are of two kinds: 1) fundamental investigations on materials, methods, and procedures, and 2) technical development of equipment and technics for practical application in the field.

It was determined very early in the program that DDT was the most promising material known for meeting the impact of returning malaria carriers.

Accordingly, activities of the laboratory were centered around the development of methods of application and evaluation of the effectiveness of this remarkable insecticide for malaria control.

Work projects cover each of the broad subjects under investigation as follows: DDT Residual Sprays, DDT Larvicides, Insect Premise Sanitation and Effects of DDT on Fish and Associated Organisms. Additional facilities set up to support all phases of the program include: 1) Equipment Development, 2) Chemical Investigations, 3) Anopheline Host Preference Studies and 4) the Insectary.

CARTER MEMORIAL LABORATORY, SAVANNAH, GEORGIA. Fundamental investigations on materials, methods, and procedures are carried on here as well as technical development of equipment and technics for practical application in the field.



DDT RE

The con  
sprays fo  
individua  
is new. I  
residual  
greatest  
laria con  
because, I  
it becom  
feasible  
control to  
regardles  
status o  
Since su  
vital to  
prosecut  
paign ag  
laria, t  
highest

FORMU  
vise, mi  
Several  
field te  
isfactor  
ting cor  
mula was  
of simpl  
dilutio  
is expre  
ingredi  
by weigh  
DDT  
Emulsif  
Xylene

For  
concent  
the rat  
concentr  
this em  
of 4 co  
mended  
square  
the lin  
availab  
used in  
This pe  
m.g. of  
mal sp



# TORY

s of the laboratory  
d the development  
ion and evaluation  
of this remarkable  
ria control.  
over each of the  
investigation as  
Sprays, DDT Lar-  
nise Sanitation,  
n Fish and Asso-  
tional facilities  
l phases of the  
quipment Develop-  
vestigations, 3)  
erence Studies,

ons on materials,  
ment of equipment



## DDT RESIDUAL SPRAYS

The concept of residual sprays for the control of individual malaria vectors is new. Potentially, DDT residual spraying is the greatest development in malaria control in many years because, for the first time, it becomes economically feasible to carry malaria control to individual homes, regardless of the financial status of the occupants. Since such an approach is vital to the successful prosecution of the campaign against imported malaria, this work carried highest priority.

**FORMULAS.** The first job was to devise, mix, and test various formulas. Several were subjected to critical field tests to determine the most satisfactory one for use under operating conditions. The following formula was finally recommended because of simplicity of mixing and ease of dilution in the field. The formula is expressed in weights and volume of ingredients and also in percentages by weight:

DDT	35 percent	3 pounds
Emulsifier	4 percent	or 6 ounces
Xylene	61 percent	3 quarts

For regular field use the spray concentrate is diluted with water in the ratio of one gallon of spray concentrate to six gallons of water. When this emulsion is applied at the rate of 4 cc. per square foot, the recommended dosage of 200 m.g. of DDT per square foot is obtained. Because of the limited supplies of DDT at first available, a 2½ percent DDT spray was used in extended program operations. This permitted an application of 100 m.g. of DDT per square foot at the normal spraying rate. With this applica-



Mixing DDT Emulsion Concentrate with power equipment consisting of a centrifugal pump, a gasoline engine and a 55-gallon drum with appropriate fittings.

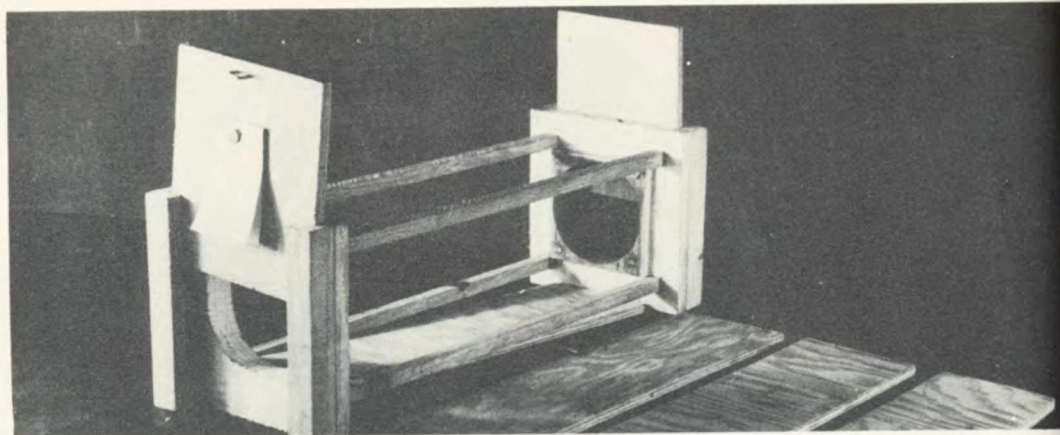
tion retreatment must be done earlier.

**MIXERS.** Various types of equipment were developed to meet the needs of a flexible operations program. Mixing equipment included a simple hand mixer and a power mixer. The latter was designed for large scale mixing at central plants. It consists of a centrifugal pump, a gasoline engine and a 55-gallon drum with appropriate fittings to permit thorough, safe and rapid mixing without the necessity of handling the solvent.

**SPRAYERS.** Two types of sprayers were recommended, one an open-head pressure sprayer suitable for hand use, and the other a small power sprayer. Sprayers were equipped with xylene resistant gaskets and hose. A nozzle giving a fan-shaped spray of about 80° and delivery of approximately 0.2 gallon per minute was found to be most satisfactory.

The spraying technic was worked out in great detail. At a pressure of 40 lbs. per square inch, properly diluted spray with the recommended nozzle, was applied at the rate of 100 m.g. DDT per square foot by covering approximately 190 sq. ft. per minute. After





EXPOSURE CHAMBER. This consists of four removable panels, totaling one square foot of surface, to which the mosquitoes were exposed.

a little practice it was possible for workmen to approximate this rate of application very closely. The nozzle was held about 18 inches from the surface being treated. It was found that great differences existed between various types of surfaces, particularly as regards run-off and residual effect of the spray deposit. Freshly enameled surfaces lost their toxicity much sooner than rough unpainted surfaces.

**PRECAUTIONS.** Safe practices were employed in the use of DDT upon the recommendation of the Industrial Hygiene Research Laboratory of the National Institute of Health. Precautionary measures included use of respirators, gloves, and goggles, and removal of DDT-oil solutions from skin and clothes with soap and water.

**EFFECTIVENESS AND DURABILITY OF DDT.** The effectiveness of DDT residual sprays was tested in the laboratory and in the field. Since the subject was entirely new, special equipment and techniques were devised for this work.

In the laboratory, tests were made in an exposure chamber constructed in such a way that four removable panels totaling one square foot of surface were available to mosquitoes during tests. Percent mortalities of *Anopheles quadrimaculatus* adults at 48 hours after exposure periods of 35, 60, 90, and 120 minutes to DDT residues of known age are shown in the accompanying table.

TABLE IV

Percent mortality at 48 hours of *quadrimaculatus* adults after 35, 60, 90 and 120 minute exposure periods to DDT residues of known age. \*

TIME AFTER TREATMENT (weeks)	PERCENT MORTALITIES AFTER EXPOSURE PERIODS. (minutes)			
	35	60	90	120
1/3	92.6	98.8	100	100
1/2	84.2	96.0	100	100
1	88.6	93.9	100	100
2	75.8	91.2	100	100
3	80.2	91.1	95.2	100
4	83.4	87.5	92.5	100
6	83.7	80.4	83.5	98.9
8	68.0	92.0	94.0	96.0
10	66.7	80.4	78.1	88.6
12	41.5	51.8	58.8	81.5
18	28.0	54.0	72.0	90.0
20	25.4	41.5	66.0	82.0

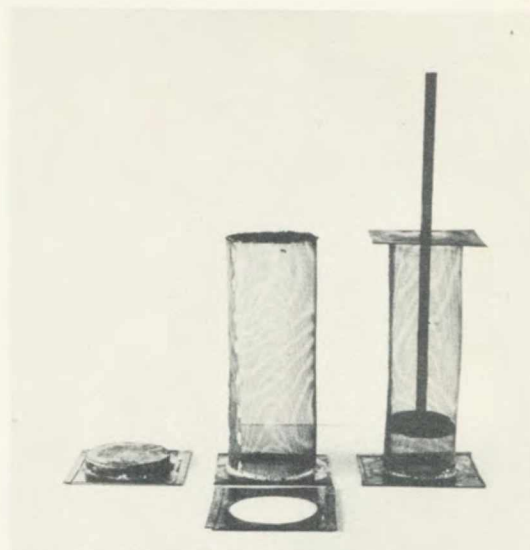
\* These data are derived from average kill of 50, 100, 200 and 300 mgs. per sq. ft. of DDT.



Wall cages were used in exposing mosquitoes to treated surfaces for testing the residual toxicity of DDT deposits in houses and other buildings. The exposure cages were 3 inches in diameter and ½ inch high, soldered to a metal base with a 3-inch central opening. Wall cages were designed to slide in and out of wall brackets and a sliding panel was used to retain the mosquitoes while handling the cage.

A cylindrical cage of the same diameter as the wall cage fitted with a plunger, was devised for placing the mosquitoes in the small test cage. A large cage was used as an observation and holding cage.

The duration and effectiveness of DDT on various types of surfaces for periods up to 21 weeks, based upon wall cage tests, are shown in the accompanying table:



WALL CAGE AND CYLINDRICAL PLUNGER. These cages are devised to hold mosquitoes for tests of the duration and effectiveness of DDT on various types of surfaces.

TABLE V

*Duration and effectiveness of DDT when used as a residual house spray, as indicated by wall cage tests in occupied houses.*

DDT DOSAGE (Mgs. per sq. ft.)	TYPE OF SURFACE	TIME AFTER TREATMENT (Weeks)	MORTALITY AFTER 48 HOURS (Percent)
100	Newspaper	19	58
100	Smooth unpainted wood	19	55
200	Rough wood	21	75
288	Smooth unpainted wood	19	53
288	Newspaper	19	71
385	Rough wood	19	70
385	Newspaper	21	93

one square foot of

IV

at 48 hours of A.  
Its after 35, 60,  
exposure periods to  
own age. \*

MORTALITIES AFTER  
PERIODS. (minutes)

90	120
100	100
100	100
100	100
100	100
95.2	100
92.5	100
83.5	98.9
94.0	96.0
78.1	88.6
58.8	81.5
72.0	90.0
66.0	82.0

from average kills  
mgs. per sq. ft.





WINDOW TRAP. These were fitted to catch mosquitoes attempting to escape from treated rooms after exposure to DDT.

Window traps and floor recovery studies gave information on the effectiveness of DDT under normal conditions. Unfortunately, most of this work had to be done in unoccupied houses but the results are nevertheless significant. Window traps were fitted to catch any mosquitoes which attempted to escape from the treated room after exposure to DDT. Mosquitoes entered through tapered inlets, or, in some instances, through doors or windows left open for the purpose. In still other cases mosquitoes were released in closed rooms fitted with window traps. The floors of such rooms in unoccupied houses were covered with paper to facilitate recovery of dead mosquitoes.

In typical tests several hundred specimens of *Anopheles quadrimaculatus* are released in a test room. They soon come to rest on the walls and ceiling where they come into contact with the deposit of DDT crystals. The first signs of DDT poisoning occur after about 10 minutes. A final accounting is taken

when all mosquitoes have been knocked down. Live mosquitoes in the window trap are removed to a holding cage and mortality checked after 24 hours. Results of typical tests are shown in the accompanying table.

TABLE VI

Summary of effective morbidity and mortality of *Anopheles quadrimaculatus* released in rooms at known periods after treatment with specific dosages of DDT

DOSAGE OF DDT (Mgs. per sq. ft.)	AGE OF TREATMENT (Weeks)	EFFECTIVE MORTALITY 24 HOURS AFTER RELEASE (Percent)
100	1 day	100
"	1	100
"	2	100
"	4	94
"	6	99
"	10	100
200	1	100
"	2	97
"	4	100
"	6	100
"	8	98
"	12	100
"	18	99.8
"	20	100
"	22	99.7
"	22	100
"	24	100
400	1 day	100
"	1	100
"	2	100
"	4	100
"	6	99
800	1 day	99.5
"	1	100
"	2	100
"	4	99
"	6	100
"	8	100
"	10	100

have been knocked  
oes in the window  
to a holding cage  
ed after 24 hours.  
ests are shown in  
ble.

## VI

morbidity and mor-  
quadrimaculatus re-  
nown periods after  
ic dosages of DDT.

OF ENT )	EFFECTIVE MORTALITY 24 HOURS AFTER RELEASE (Percent)
	100
	100
	100
	94
	99
	100
	100
	97
	100
	100
	98
	100
	99.8
	100
	99.7
	100
	100
	100
	100
	100
	99
	99.5
	100
	100
	99
	100
	100
	100

## DDT AS AN ANOPHELINE LARVICIDE

DDT is toxic to mosquito larvae in such minute quantities as 0.05 lb. per acre of water surface or one part DDT emulsion per ten million parts of water by volume. Despite high toxicity there are certain inherent disadvantages in its use as a larvicide. For spraying, it is insoluble in water and hence must be dissolved in oil or some other solvent. As a dust, it is slightly sticky and hence must be mixed with an inert carrier under special conditions. Amounts that can be applied with safety to wildlife are readily inactivated by mud, so there is little or no residual effect. Tests have been performed with a view toward devising means of overcoming these difficulties.

Various dust formulas were tested including a dust containing one percent DDT in pyrophyllite. This mixture in dosages from 1.0 to 0.025 pounds of DDT per acre gave strikingly uniform kills (95% larval reduction or better).

Sprays have been tested utilizing atomizing nozzles. Results with this equipment are shown in the accompanying table. The spray formula consisted of 1.25 percent DDT in No.2 fuel oil with 0.5 percent emulsifier. It will be noted that Station 12 with 97% mortality after 48 hours at 0.05 lbs. DDT per acre was the most promising of the tests.

Even smaller amounts of DDT can be spread evenly over water surface in the form of "thermal aerosols." DDT

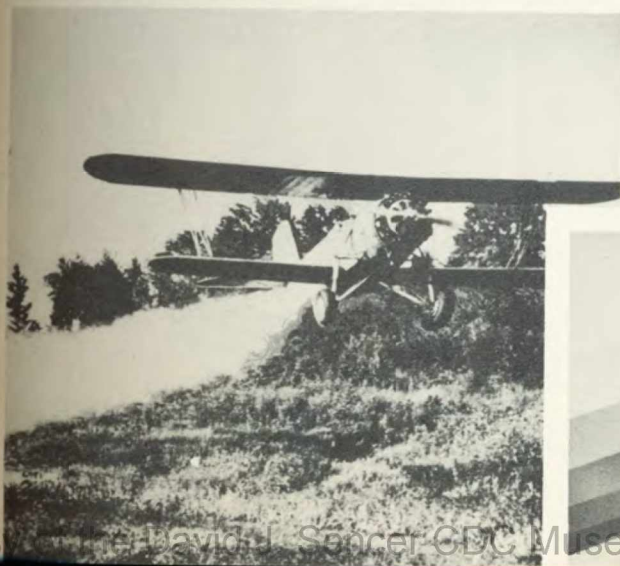
TABLE VII

Mortality obtained with indicated DDT dosages applied as 1.25 percent DDT in No.2 fuel oil (containing 0.5 percent emulsifier).

STATIONS	DDT DOSAGE LBS./ACRE	ANOPHELINE LARVAE MORTALITY (percent)	
		24 hrs.	48 hrs.
1	0.1	97	99
2	0.1	89	91
3	0.1	88	93
4	0.1	93	89
5	0.1	94	--
6	0.1	--	88
7	0.1	72	65
8	0.1	--	98
9	0.1	95	80
10	0.1	94	98
11	0.1	95	95
12	0.05	--	97
13	0.05	--	90

is dissolved in a solvent which is vaporized easily. Small amounts of the resulting solution are then pumped into the exhaust stream of an airplane or a jeep. The result is a cloud of smoke particles intermixed with a fog of extremely small droplets of DDT in solution. Much of this work was carried on in cooperation with the "thermal aerosol" project of the Tennessee Valley Authority at Wilson Dam.

THERMAL AEROSOL. (Left) Small amounts of DDT can be spread evenly over water surface by airplane. (Below) Close-up of venturi tube used by TVA to distribute thermal aerosol.



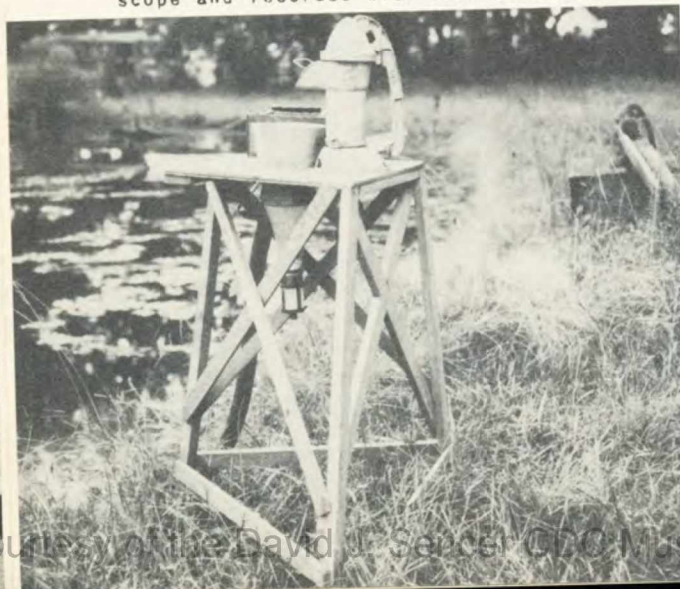


In order to compare the effectiveness of DDT with paris green in routine MCWA operations, the regular MCWA project at Savannah was converted to DDT. Twenty-three areas treated in the usual manner with paris green showed an average reduction of 70 percent after 24 hours. Reduction in third and fourth stage larvae was satisfactory but the material was much less effective against the first two instars.

Results with DDT in dusts and in fuel oil showed the material to be equally effective against all instars. Sixteen breeding places treated with one percent DDT in pyrophyllite showed an average total reduction of 98 percent and ten areas treated with DDT in fuel oil showed an average reduction of 96 percent.

The practical application of these studies is obvious. Use of DDT as an anopheline larvicide shows promise of increasing the mortality of all stages of larvae and decreasing the amount of material applied. This last factor is especially important. About eighty percent of the cost of larviciding with oil or paris green is expended in labor. There is a possibility of reducing this factor by lightening the load of individual laborers and eliminating the costly return trips to a central point for refilling spray tanks. This could conceivably double the efficiency of larvicidal operations and thus cut the cost in half.

PLANKTON COLLECTOR. (Left) This device is used in tests of the effect of DDT on aquatic organisms. COUNTING PLANKTON SAMPLES. (Right) Specimens are examined under the microscope and recorded with automatic tabulator.



## EFFECTS OF DDT ON FISH AND ASSOCIATED ORGANISMS

The widespread use of DDT as an insecticide in mosquito control is contingent upon its over-all effect on fish and other wildlife. A delicate balance exists in the biota of any environment and it is essential to determine the extent to which DDT upsets this balance. For example, does DDT eliminate all fish food when applied as a larvicide? At what concentration does it kill the fish outright? What is its effect on wild bees which are so vitally concerned in the pollination of so many commercial crops? These and other questions are being answered in cooperation with the Savannah National Wildlife Refuge, which is operated by the Fish and Wildlife Service, U.S. Department of the Interior, and with the Plant Introduction Laboratory of the Bureau of Plant Industry, U.S. Department of Agriculture.

Results are not yet available but in a general way it appears that a margin of safety exists between the concentration of DDT satisfactory for mosquito control and the concentration injurious to wildlife. Of great importance in this connection is the form in which the DDT is applied. Stable emulsions appear to be injurious to fish whereas dusts seem to be relatively innocuous.

DDT SPRAY  
One bad  
dairy was  
a 2½ perc  
lene emul  
still sho  
factory  
months la  
tempt is  
to establ  
tical an  
procedure  
of DDT b  
dairies,  
abattoirs

INS  
The p  
housefly  
standpoi  
to estab  
procedur  
of dair  
and mark

Resid  
used in  
ed in s  
stances,  
flies in  
dairy w  
DDT-Xyle  
ing sat  
later. I  
mises c  
mediate  
96.9 pe  
Cove  
other f  
to be s  
in most  
are so  
breedin  
a spray  
of manu  
adult f



## ON FISH ORGANISMS

f DDT as an in-  
control is con-  
effect on fish  
elicate balance  
any environment  
determine the  
sets this bal-  
DDT eliminate  
ied as a larvi-  
on does it kill  
is its effect  
so vitally con-  
ion of so many  
and other ques-  
in cooperation  
onal Wildlife  
ed by the Fish  
.S. Department  
the Plant In-  
the Bureau of  
rtment of Agri-

available but  
ars that a mar-  
etween the con-  
actory for mos-  
centration in-  
great impor-  
on is the form  
d. Stable emul-  
rious to fish  
relatively in-

DDT on aquatic  
nder the micro-



**DDT SPRAYING OF BARN.**  
One badly infested  
dairy was treated with  
a 2½ percent DDT-Xy-  
lene emulsion and is  
still showing satis-  
factory control 10  
months later. An at-  
tempt is being made  
to establish a prac-  
tical and efficient  
procedure for the use  
of DDT by owners of  
dairies, restaurants,  
abattoirs and markets.



## INSECT PREMISE SANITATION

The primary aim of this project is  
housefly control from the public health  
standpoint. An attempt is being made  
to establish a practical and efficient  
procedure for the use of DDT by owners  
of dairies, restaurants, abattoirs  
and markets.

Residual sprays similar to those  
used in mosquito control have result-  
ed in satisfactory and, in some in-  
stances, spectacular control of house-  
flies in dairies. One badly infested  
dairy was treated with a 2½ percent  
DDT-Xylene emulsion and is still show-  
ing satisfactory control 10 months  
later. Complete treatment of all pre-  
mises of two dairies showed an im-  
mediate reduction of 92.4 percent and  
96.9 percent respectively.

Coverage of walls and ceilings and  
other fly resting places has proved  
to be sufficient for adequate control  
in most cases. However, some dairies  
are so insanitary that some control of  
breeding is necessary. In these cases,  
a spray may be applied to the surface  
of manure piles. The object is to kill  
adult flies as they emerge rather than

attempt the more difficult job of kill-  
ing the larvae. This is a temporary  
measure and should not be used in lieu  
of clean-up of the premises.

**RESTAURANTS.** Average counts of  
houseflies in eating establishments,  
utilizing a small counting grill 18"  
square, gave 12.75 flies during the  
pretreatment period and 1.17 flies dur-  
ing the post-treatment period. The  
greatest limiting factor in restau-  
rant fly control is the difficulty of  
making a treated surface available to  
flies which enter during the day. At  
night the flies rest on the walls and  
ceiling and on such favored places  
as edges of doors and light cords.  
Here they come into contact with suf-  
ficient DDT so that a treated restau-  
rant is completely free of flies at  
the beginning of each day.

To prevent excessive invasion of  
flies from outside, some work has been  
done on fly control around garbage  
cans in alleys. This approach or even  
complete coverage (environmental fly  
control) of entire city blocks may  
alter the picture of general sanita-  
tion in the future.



## ANOPHELINE HOST PREFERENCE STUDIES

During 1944 tests were run on the blood meals of 38,932 engorged female anophelines from 28 States, the District of Columbia, and Puerto Rico. The specimens were collected by MCWA personnel while performing routine inspections of adult stations on control projects. The data supplied with each collection included locality, place collected, species of mosquito, distance from nearest available continual source of human blood, whether this source was screened or unscreened, the name of the collector and date collected.

The Rice and Barber technic of mass precipitin testing is used. This technic involves soaking the blood from the filter paper on which it was originally collected and bringing the resulting mixture (antigen) into contact with prepared human, equine, bovine, porcine, and avian antisera in five capillary tubes attached to glass slides. A precipitate appears in the tube which contains antisera against the blood of the host that the mosquito fed upon, thus indicating the source of the original blood meal.

Results of the year's tests show that 3.27 percent of the blood meals of *Anopheles quadrimaculatus* were from

human hosts. All *Anopheles* species other than *crucians* fed upon human hosts to a greater extent than did *quadrimaculatus*. However, comparatively few collections were made inside houses.

A distinct seasonal variation in human blood meals was indicated, specimens collected during the early months of the year showing a low percentage of human blood meals. A sudden rise to 15.5 percent occurred during April. A drop in early summer was followed by an increase in the fall with a more gradual drop toward the winter months. After an early summer drop, *punctipennis* and *pseudopunctipennis* showed the highest human blood meals, *punctipennis* having taken nearly three times as many human blood meals as did *quadrimaculatus*.

A considerable difference was noted in the percent of human blood meals of specimens from various States. For example, the percent of *Anopheles quadrimaculatus* feeding on human hosts in Arkansas was over twice as high as that in Louisiana. This striking difference will probably be explained when the data are analyzed as to source of collection. As in previous tests, by far the greatest percentage of blood meals was bovine in origin.

TABLE VIII  
Percent of anophelines found positive for human, equine, bovine, porcine, and avian blood. 1944.

SPECIES OF ANOPHELES	NO. OF SPECIES TESTED	H	E	B	P	A	NO REACTION
1. <i>quadrimaculatus</i>	29,511	3	23	48	11	4	11
2. <i>punctipennis</i>	2,939	3	13	56	12	4	11
3. <i>crucians</i>	3,077	3	12	58	12	4	11
4. <i>pseudopunctipennis</i>	1,208	6	5	67	9	3	10
5. <i>freeborni</i>	593	5	9	57	7	5	15
6. <i>albimanus</i>	1,548	7	4	73	5	2	8

nopheles species  
as fed upon human  
r extent than did  
ever, comparative-  
were made inside

onal variation in  
indicated, speci-  
g the early months  
a low percentage  
s. A sudden rise  
rred during April  
mer was followed  
e fall with a more  
he winter months.  
er drop, *puncti-*  
*ctipennis* showed  
od meals, *puncti-*  
early three times  
eals as did *quad-*

ference was noted  
man blood meals  
ious States. For  
f *Anopheles quad-*  
n human hosts in  
e as high as that  
iking difference  
lained when the  
o source of col-  
s tests, by far  
e of blood meals

ne, bovine,

## EQUIPMENT DEVELOPMENT

Throughout the year special types of equipment have been needed in connection with the investigational and operational programs. A power mixer for the preparation of DDT emulsions, a portable power sprayer, a thermal aerosol generator and numerous other items were developed. Also, commercially available sprayers and other equipment had to be modified for purposes of malaria control. Xylene resistant gaskets and hose were selected after extensive tests. Spray nozzles for use on the Extended Program were tested for rate of discharge and evenness of spray swath. In general it may be said that equipment development was an integral part of practically every phase of the investigational program.

## CHEMICAL INVESTIGATIONS

Laboratory studies on the chemistry of DDT played an important part in the over-all program. The solubility of DDT in various solvents was tested, the chemical properties of a DDT isomer were investigated and studies were made of the explosiveness of vapors of several organic solvents used in connection with DDT interior residual spraying.

In no case did explosive concentrations occur during the investigation, as measured by a combustible gas indicator.

## INSECTARY

An insectary was maintained to supply mosquito larvae and adults for testing purposes. The insectary has a capacity for producing 10,000 "quads" per day. Five hundred white enamel pans are used for rearing larvae and six colony oviposition cages house the stock colonies. The air temperature of the room is held at 80° - 82° F. and the relative humidity at 80 percent. The temperature of the larval cultures is 78° - 79° F.

A rearing cycle is started each day with eggs laid during the preceding night. Approximately 1,000 eggs are placed in each pan and are held within a waxed paper ring to prevent stranding on the edges of the pan. Water from a nearby artificial pond is used. Larval food consists of brewers yeast and finely ground dog biscuit.

Special studies have been conducted on the technic of larval rearing and oviposition habits — both studies having a direct bearing on the maintenance of the colony at maximum production.

This insectary at Savannah, Ga., has a capacity for producing 10,000 "quads" per day. White enamel pans are used for rearing larvae and colony oviposition cages house stock colonies.

NO REACTION	
11	
11	
11	
10	
15	
8	



Courtesy of the David J. Sencer CDC Museum



# DDT INVESTIGATIONS PUERTO RICO

Having determined that DDT as a residual spray is toxic to mosquitoes, it might be assumed, *a priori*, that DDT will control malaria, but malaria is a complicated disease and many factors are involved in its transmission. So a field test was undertaken in Puerto Rico where records of malaria incidence indicated that significant results might be obtained. The work was conducted by personnel of the Carter Memorial Laboratory in cooperation with the Insular Health Department, the School of Tropical Medicine, and the Public Health Service District Office.

Playa de Humacao was selected as the village to be sprayed and Loisa Aldea was used as a check. Playa de Humacao is a small town (2,500 population) located near the southeast corner of the island of Puerto Rico. The temperature varies from 65° to 85° F. (minimum daily average). During the course of the experiment some 20 inches of rain fell (December 1944 through June 1945). Most of the people in the village work as stevedores or laborers in the sugar cane plantations. The average family income is probably less than \$500.00 per year, earned for



DDT TEST HOUSE IN PLAYA DE HUMACAO. Mosquitoes were released at regular intervals to test DDT residual toxicity.

the most part during the months of February through May, when the sugar is loaded on ocean-going freighters. The village is neat in appearance with well-kept houses and relatively clean streets and yards. None of the houses are screened and even if they were, considerable transmission of malaria could possibly occur because the people sit outdoors in the evenings either on their porches or at "cafetines" (local coffee shops).

The malaria incidence had been high in Playa de Humacao. An Insular Health Department Survey indicated a rate of approximately 20% before the experiment. However, this was a selective survey. Blood slides were taken only from persons who reported symptoms that might be indicative of malaria. A complete blood slide survey at the beginning of the experiment showed only 5.9% positive slides for Playa de Humacao and 4.7% for Loisa Aldea.

The first spraying was done in Playa de Humacao from November 1 to 18, 1944 using a 5% solution of DDT in kerosene. This operation met with enthusiastic cooperation on the part of the villagers because of the immediate effect of the spray on bedbugs, cockroaches and other insect pests. The second spraying began on June 30, 1945. The DDT-Xylene emulsion was used for the second spraying and 513 houses were covered in 13 working days. The second parasitemia survey showed a decrease in positive slides in both areas but the difference between the two is not statistically significant. There were 2.8% positive slides found in Playa de Humacao and 1.5% positive slides in Loisa Aldea.

Final results will not be available until a complete season has passed. However, it may be said from evidence so far available, that the residual toxicity of DDT to the Caribbean malaria vector, *Anopheles albimanus*, is about the same as for *Anopheles quadrimaculatus* in the continental United States.

## DDT II MEMPHIS

The Division of the NIH has malaria investigations greatly from Malaria Investigations, Memphis, and, phases of the tion of funds

Four projects part of the I spraying study square mile r kansas. A total with DDT resi the effective practical ap house spray a trol in rural early in the way toward this method

Second, la ducted on DI and crystal subject was by the Memphis laboratory, Authority, a because of be done and desirable to dence on th

Third, th took studies completely vicide using in oil spra gallons per percent we tion of ap labor cost cide cost.

Fourth, ing one se the Arkans Station, t ness of DI breeding i sion of DDT the floodin



## DDT INVESTIGATIONS MEMPHIS LABORATORY, NIH

The Division of Infectious Diseases of the NIH has a long term program of malaria investigations. MCWA benefited greatly from the cooperation of the Malaria Investigations Laboratory in Memphis, and, in turn, supported certain phases of the Memphis work by allocation of funds and personnel.

Four projects were undertaken as a part of the DDT studies. First, house spraying studies were conducted in a 36 square mile rural area near Helena, Arkansas. A total of 513 houses were treated with DDT residual spray to demonstrate the effectiveness, inexpensiveness, and practical application of DDT residual house spray as a method of malaria control in rural areas. This work was done early in the program and pointed the way toward the eventual adoption of this method in the Extended Program.

Second, laboratory studies were conducted on DDT solvents, emulsifiers, and crystal formations. This general subject was investigated independently by the Memphis laboratory, the Savannah laboratory, and the Tennessee Valley Authority, as well as by other agencies, because of the vast amount of work to be done and because it was considered desirable to obtain corroborative evidence on the subject.

Third, the Memphis laboratory undertook studies which showed that DDT was completely effective as a surface larvicide using a 1 to 3 percent solution in oil sprayed at the rate of 4 to 10 gallons per acre. Kills of 95 to 100 percent were obtained with a reduction of approximately 60 percent in labor cost and 70 percent in larvicide cost.

Fourth, a study was conducted during one season, in collaboration with the Arkansas Stuttgart Rice Experiment Station, to determine the effectiveness of DDT in controlling mosquito breeding in rice fields. Water emulsion of DDT was applied at the pump to the flooding waters of a 100-acre rice



Application of DDT to irrigation water.

field. Complete mosquito control was obtained near the pump and in the canal. In areas surrounding the water entrance there was a gradual loss in toxicity as the water flowed to the far side of the field. In comparison with an untreated field, 50 percent fewer *A. quadrimaculatus* larvae and 72 percent fewer culicine larvae were found in the treated field. A significant reduction, 50 percent, was observed in the rice water-weevil population, and no injury to rice was noted. In fact, harvested rice yields were highest ever reported from this Experiment Station.

In addition to the investigational projects, over 45,000 blood films taken for survey purposes were examined at the Memphis Laboratory as a cooperative project with MCWA.



Sampling Populations of Larvae in Treated Rice Field.



## MALARIA FIELD STUDIES SOUTH CAROLINA

In most areas throughout the South, including South Carolina as a whole, malaria has been decreasing and is now at an all-time low. However, the Santee-Cooper reservoir area is one of the few remaining endemic areas in the country. In studying records collected from this area over the last ten years, it is evident that a clear-cut focus of malaria has existed and continues to exist in the vicinity of the Santee River in Clarendon, Berkeley and Orangeburg counties. Furthermore, these studies indicate that in some sections malaria has increased since the 1941 impoundage of water in the Pinopolis and Santee Basins, and that minor epidemics occurred during the seasons of 1942 and 1943 in Clarendon County near the Santee Reservoir.

### SANTEE — COOPER SURVEY

Early in 1944, at the request of the South Carolina State Board of Health and the South Carolina Public Service Authority, an intensive survey of the Santee-Cooper area was made. The survey included epidemiological, entomological and engi-



The larger Santee Reservoir contained 47,112 acres of standing timber, most of it dead, with considerable floatage and piles of fallen branches.

neering studies and was designed to furnish complete data upon which to base a control program.

**CONDITION OF THE RESERVOIRS AT THE TIME OF THE SURVEY.** Of the two reservoirs, the Santee Reservoir is the largest — 30 miles long and  $3\frac{1}{2}$  miles wide on the average — with a maximum water surface of 97,000 acres and a shoreline of over 497 miles at the 75-foot contour. The smaller Pinopolis Reservoir, connected to the Santee by a diversion canal, is about 12 miles long and 10 miles wide and has a maximum water surface of about 65,000 acres and a shoreline of 151 miles at the same elevation.

At the time of the survey the lower impoundment, the Pinopolis Reservoir, had been entirely cleared of standing timber and floating logs. Aquatic plants had not invaded this impoundment to any extent except where they had been implanted in the Pinopolis Pool Wildlife Refuge on the south side of the lake. This refuge covers 2,000 acres, is well located, and was not considered important from the malaria standpoint because few people lived within flight range.

The larger Santee Reservoir, on the other hand, contained 47,112 acres of standing timber, most of it dead, with considerable floatage and piles of fallen branches. In the lower half of this reservoir, a mile-wide cleared strip of open water separated the flooded timber from the shoreline; but in the upper half, this strip was only one-half mile in width. In some places, these cleared strips of open water were quite deep; in others, the summer recession of the water level gradually exposed acres of stumpage. In a few places, the development of secondary growth and herbaceous vegetation had created serious mosquito breeding situations. Alligator grass, in particular, threatened to become a serious problem over much of the area. In addition, several wildlife refuges with sustained water levels had been established on the reservoir. Where aquatic and semi-aquatic vegetation developed, these refuges presented a considerable anopheline hazard.

**MALARIA PREVALENCE.** Epidemiological studies from 1944 to secure prevalence of malaria in the entire area of the 75-foot contour from more distant from the reservoir than the normal incidence region. Some studies were completed in 1944. Complete facts on the condition of malaria in the houses were

The area was located in the Santee Reservoir around Potomac Creek. Films examined sites. The this section area in the Santee Dam. Prevalence — blood smear prevalence, rare occurred in mentioned areas show prevalence

Detailed made to locate breeding places. The principal was occurred in the two-third Santee Reservoir greatest in the breeding areas available as a studied in over wide mosquito a mile at

Detail control



designed to fur-  
which to base a

ERVOIRS AT THE  
the two reser-  
r is the largest  
les wide on the  
n water surface  
oreline of over  
t contour. The  
oir, connected  
sion canal, is  
10 miles wide  
urface of about  
ne of 151 miles

vey the lower  
Reservoir, had  
tanding timber  
ic plants had  
ent to any ex-  
been implanted  
ife Refuge on  
. This refuge  
located, and  
ant from the  
e few people

voir, on the  
112 acres of  
t dead, with  
iles of fal-  
half of this  
red strip of  
ooded timber  
e upper half,  
alf mile in  
ese cleared  
ite deep; in  
of the water  
s of stump-  
velopment of  
ous vegeta-  
quito breed-  
ss, in par-  
e a serious  
a. In addi-  
s with sus-  
established  
c and semi-  
these ref-  
anopheline

**MALARIA PREVALENCE.** A widespread epi-  
demiological survey was undertaken in  
1944 to secure information regarding the  
prevalence and distribution of malaria.  
Blood smears were obtained throughout the  
entire area lying within  $1\frac{1}{2}$  miles of the  
75-foot contour. Smears were also taken  
from more distant areas — 3 to 10 miles  
from the reservoirs — as a check on the  
normal incidence of the disease in the  
region. Some 15,000 individuals were ex-  
amined in houses or at work in the fields.  
Complete family rosters, data regarding  
the condition of the house, and a history  
of malaria were obtained. About 6,000  
houses were surveyed.

The area of highest malaria prevalence  
was located on the north shore of the  
Santee Reservoir in Clarendon County  
around Potato Creek, between Tawcaw and  
Wyboo Creeks. Here 38.7% of the 470 blood  
films examined proved positive for para-  
sites. The area immediately adjacent to  
this section in Clarendon County and the  
area in Berkeley County just below the  
Santee Dam showed the next highest pre-  
valence — 11.3 to 15.7 percent positive  
blood smears. Relatively moderate prev-  
alence, ranging from 6.7 to 8.9 percent  
occurred in areas adjacent to the above  
mentioned high sections. The remaining  
areas showed a relatively low degree of  
prevalence.

Detailed entomological surveys were  
made to locate the most favorable mosquito  
breeding places and to determine whether  
the principal breeding of *quadrimaculatus*  
was occurring in the reservoirs proper  
or in the adjoining territory. The upper  
two-thirds of the flooded woods in the  
Santee Reservoir were found to be the  
greatest single source of *quadrimaculatus*  
in the entire region. The extremely high  
breeding intensity and the thousands of  
acres available for breeding marked this  
area as a serious problem. Other problems  
studied included dispersal of mosquitoes  
over wide expanses of open water and  
mosquito breeding amidst flooded timber  
a mile and a half from shore.

Detailed plans were submitted for the  
control of malaria in the Santee-Cooper



Entomological surveys revealed heavy  
breeding in the flooded woods of the  
Santee Reservoir.

area. The following temporary measures  
were recommended pending inauguration of  
the permanent program: 1) Larviciding to  
kill the aquatic stages of mosquitoes; 2)  
Spraying to kill adult mosquitoes in  
houses; 3) Removal of secondary growth  
from the reservoir areas; 4) Control of  
aquatic plants that form favorable breed-  
ing places for *quadrimaculatus*; 5) Use of  
drugs to reduce infection in the human  
population. The more permanent type meas-  
ures included: 1) Clearing of the partially  
submerged timber in which heavy breeding  
of *quadrimaculatus* occurred in 1944; 2)  
Drainage of ponds in the zone of fluctu-  
ation; 3) Mosquito-proofing of houses in  
certain areas where control would be most  
difficult; 4) Shoreline improvement; 5)  
Diking and dewatering of several areas  
where malaria rates were high and a large  
number of people were affected; 6) Filling  
of small areas to reduce larvicidal work.



## MALARIA FIELD RESEARCH

A field study was undertaken in cooperation with the South Carolina Board of Health to test the basic assumption that DDT controls malaria as a result of the residual house spray killing mosquitoes which transmit the disease. Two rural areas were selected which had been shown by previous parasitemia surveys to have sufficient malaria to enable statistically significant comparison of results to be made. Each study area was divided into a "test" and a "control" area based upon topography, size of area and characteristics of the population.

and mapping the houses and by recording the condition of the houses and screens. A population census is kept including the name, sex, race, age and length of residence of each person in the area. A record is kept of changes of persons from one house to another, names of new people moving into the area and names of deceased persons and those leaving the area. A complete census is kept of stables and other outbuildings and an animal census was made, noting the number of mules, cows, pigs, and fowls in each house group. These data serve as a basis for correlating information on host preference and sporozoite rates with malaria prevalence.

Cases were established a medical of case history physical examination of malarial blood smears carefully disease.

PARAS blood smears Area I divided each month and in Area of every 1,000 slides in Diseases I State Board

MOSQU mological information of Anopheles areas for rates in obtained dual effect in test

In Area counts farmsteads farms set of a stationing place quito p all out beneath on farm sent. D in station These station a control of temperature Only made since been ap

In are living at 20 p are made

TABLE IX

*Characteristics of Study Areas*

	CONTROL	TEST	CONTROL	TEST
	IA	IB	IIA	IIB
Length . . . . .	6 miles	8 miles	5 miles	5 miles
Breadth . . . . .	5 miles	6 miles	4 miles	2 miles
Area . . . . .	25 sq. mi.	40 sq. mi.	15 sq. mi.	7 sq. mi.
No. occupied houses . . . . .	256	334	94	103
No. inhabitants . . . . .	1,390	1,824	417	483
Parasitemia prevalence . . . . . (Oct. 1944)	16.4%	20.9%	8.4%	11.0%

**ORGANIZATION OF THE STUDY.** The efficacy of DDT as a residual house spray in preventing new cases of rural malaria is being gauged by carefully collected morbidity information. Entomological, climatological, and other pertinent data are being obtained to evaluate conditions related to malaria transmission. In short, every effort is being made to obtain a complete picture of malaria in the test areas before, during, and after treatment with DDT.

Housing is studied by means of a complete housing census, by numbering

**CLINICAL CASE STUDY.** Each household in Study Area 1 is visited semi-monthly and notations are made regarding the health status of each person and his use of anti-malarial drugs. The symptoms manifested by those individuals who are ill or who have been ill during the two weeks prior to the visit are recorded. Entomological inspectors, while making their rounds of stations, note persons ill in bed and report to the medical officer. The purpose of this case screening is to pick out individuals on whom more detailed study by a medical officer is warranted.



and by record-  
he houses and  
ensus is kept  
race, age and  
ach person in  
of changes of  
another, names  
the area and  
nd those leav-  
ensus is kept  
buildings and  
e, noting the  
gs, and fowls  
se data serve  
g information  
rozoite rates

TEST
IIB
5 miles
2 miles
7 sq.mi.
103
483
11.0%

household in  
-monthly and  
g the health  
use of anti-  
manifested  
ill or who  
weeks prior  
tomological  
r rounds of  
bed and re-  
The purpose  
ick out in-  
ailed study  
anted.

Cases warranting further study to establish a diagnosis are visited by a medical officer. He obtains a complete case history and performs a comprehensive physical examination. All clinical cases of malaria receive adequate anti-malarial treatment. Cases are followed carefully throughout the course of the disease.

**PARASITEMIA SURVEY.** A thick film blood smear survey is carried out in Area I during the first two weeks of each month (approximately 3,000 slides) and in Area II during the first two weeks of every second month (approximately 1,000 slides). The slides are being examined in the Division of Preventable Diseases Laboratory of the South Carolina State Board of Health.

**MOSQUITO POPULATION STUDIES.** Entomological observations provide information on the relative densities of *Anopheles quadrimaculatus* in the test areas for comparison with the malaria rates in these areas. Data are also obtained for comparison of the residual effect of DDT (inside house counts in test vs. control areas).

In Area I weekly anopheline mosquito counts are made at 20 percent of the farmsteads, using as "index stations" farms selected because of the presence of a stable regarded as a desirable resting place. Counts are made of the mosquito population inside of houses, in all outbuildings and, occasionally, beneath houses, in hollow trees, and on farmsteads where no stable is present. Daily anopheline counts are made in stables at six selected stations. These supplement the regular weekly station counts and are compared with a continuous hygrothermograph record of temperature and humidity in the area. Only occasional larval surveys are made since breeding places have already been appraised during previous surveys.

In Area II entomological surveys are limited to weekly mosquito counts at 20 percent of the farmsteads. Counts are made inside houses and in all out-

buildings in both control and test areas.

The sporozoite rate is determined in the test area vs. the control area by dissection of mosquito salivary glands. A 10 percent sample of mosquitoes is taken from the out-buildings, but not over 100 mosquitoes are taken from a single farmstead.

Precipitin tests are run on blood samples from the above mosquitoes after dissection of the salivary glands.

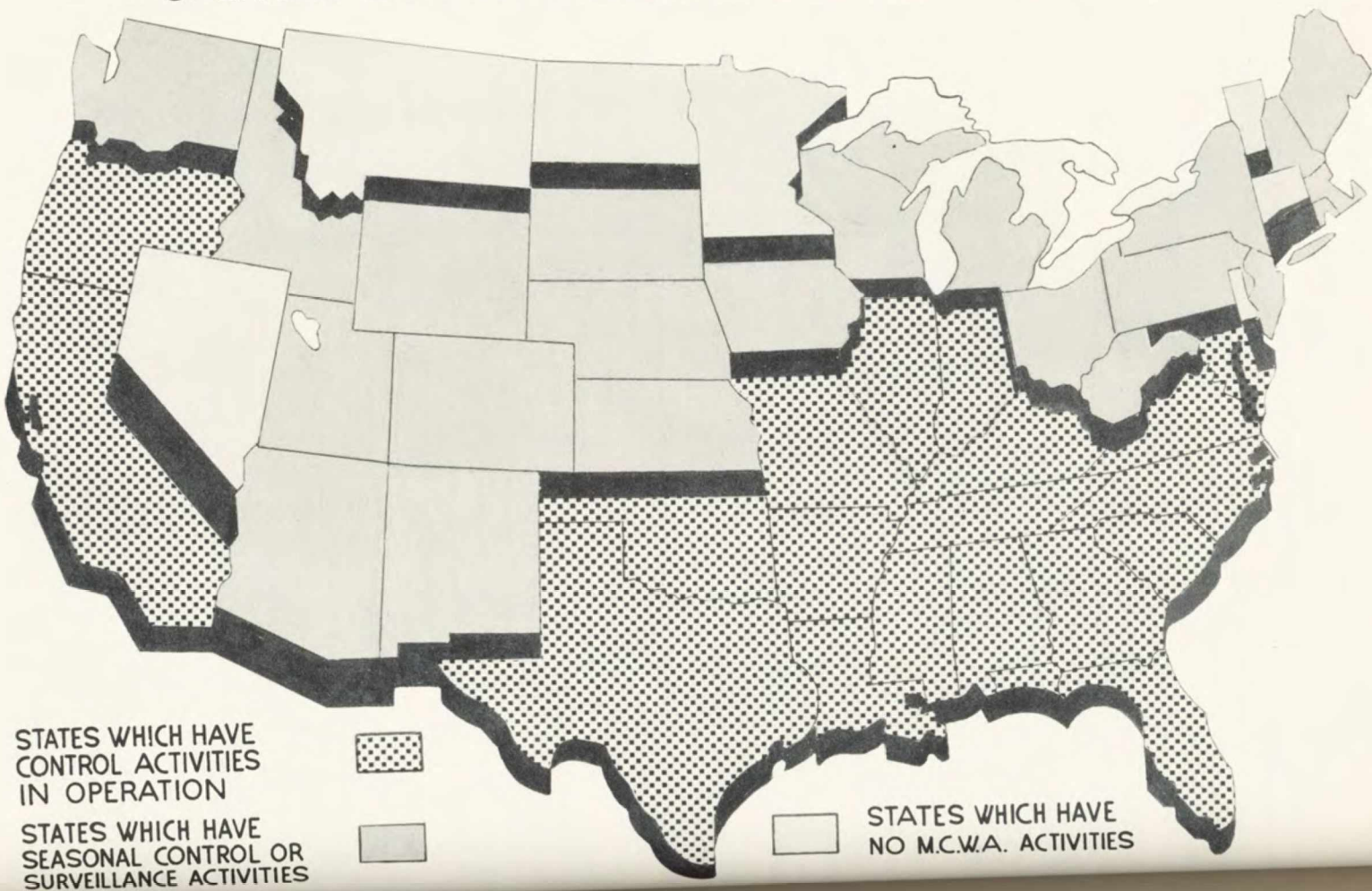
**DDT RESIDUAL HOUSE SPRAYING.** All houses in Areas I and II were sprayed during the last two weeks of April at which time mosquito counts had begun to reach significant figures. The spraying will be repeated three months later. Spraying operations were carefully supervised for thoroughness. Walls and ceilings were sprayed and also backs of furniture and pictures and both sides of mattresses and springs. The exact date of spraying of each house was recorded.

**RESULTS.** No general conclusions are warranted on the basis of present data, but the schedule of the blood smear survey is being met with smears obtained in Area I during the first two weeks of every other month. The sampling of the population is being maintained at over 90 percent. Two surveys have been carried out in Areas I and II in April and June.

When complete data are available it is expected that any differences in parasite prevalence between the test and control areas will be evident. If a significantly higher rate is demonstrated in the control areas, it can be assumed that a reduction in the amount of malaria transmission in the sprayed area has been affected. Data being accumulated on clinical malaria, mosquito densities, sporozoite rates and percentage of human blood meals in both test and control areas, should aid in evaluating the efficacy of DDT residual house-spraying in preventing new cases of malaria.



## OPERATIONS OF MALARIA CONTROL IN WAR AREAS





# ALABAMA

BURTON F. AUSTIN, M.D.  
State Health Officer

## PROJECTS

1. Huntsville
2. Montgomery
3. Tuskegee
4. Decatur
5. Mobile
6. Aliceville
7. Foley
8. Selma
9. Gadsden
11. Tuscaloosa
12. Courtland
13. Dothan
14. Ozark
15. Opelika
16. Anniston
17. Chantom
18. Loxley
19. Evergreen
20. Greenville
21. Clanton
22. Point Clear
23. Greene
24. Jackson
- ★ Montgomery

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

The accomplishments of MCWA for the past fiscal year are presented under three headings: (1) Regular MCWA, (2) Extended program, (3) *Aedes aegypti* Unit.

## REGULAR MCWA

Two additional war areas were established within the State during the fiscal year while 3 were abandoned or dropped giving a total of 21 areas involving malaria protection of 110 war establishments.

An average of 39 employees including State Office personnel and those

attached to four area headquarters offices were detailed to regular MCWA operations during the year.

Control activities consisted principally of ditch and pond cleaning and entomological surveillance. Larvicidal operations, except for occasional treatment of sporadic breeding areas, were limited to the Mobile and Chantom areas.

**WATERED AREA CENSUS.** In the watered area census of zones under MCWA control, approximately 2,500 acres of ponded water and 207 miles of ditches were recorded. Of these, 512 acres and 106 miles respectively were permanently watered.



Of permanently watered areas, 120 acres of ponds and 7 miles of ditches produced anopheline mosquitoes either continuously or frequently, while anopheline breeding was found in 58 acres of ponds and 6.8 miles of ditches which contain water infrequently or occasionally during the mosquito breeding season.

**DRAINAGE.** Some idea of the extent of drainage operations since 1941 may be obtained by comparing these figures of total watered area with the total of 920 acres of watered surface eliminated by drainage operations.

Minor drainage was performed in 7 of the 21 war areas. Approximately 34 acres of watered surface were eliminated through the construction of 37,700 linear feet of lateral ditches requiring the excavation of 6,400 cubic yards of earth and 9,335 man-hours of labor.

**LARVICIDING.** In the seven areas where drainage was done, larviciding was also practiced. The efficiency of the latter operations was improved by removal of vegetation from 54 acres of ponded water involving 7,565 man-hours. Also, 162 acres of ditch area were cleaned using 33,046 man-hours.



**LOADING SAWDUST.** Small bodies of water were filled with sawdust which was an available material and was easy to handle.

There were 644 acre treatments with 1,013 pounds of paris green, requiring 1,659 man-hours.

Approximately 280 acre treatments were made with 5,550 gallons of oil, an expenditure of 3,033 man-hours.

**ENTOMOLOGICAL SURVEILLANCE.** The remaining 13 of the 21 war areas were under entomological surveillance. The State Entomologist and area personnel routinely inspected 283 mosquito collecting stations during the year. Of this number, two "A" stations or 0.7% showed counts often or more *Anopheles quadrimaculatus* for three consecutive weeks while from five to ten *A. quadrimaculatus* were collected from eight "A" stations or 2.8% for similar periods of time.

**POW CAMP SITES.** At the request of the War Manpower Commission, investigations were made of 11 proposed sites for prisoner-of-war camps, and representatives of the State Office accompanied the Army Site Boards on final inspections. This arrangement has proven its worth in that control other than entomological surveillance has not been necessary around sites selected under these conditions.

EXT

In January, Officer received with the organization Program in Alabama the highest man selected for Autauga, Montgomery Lowndes (Area 23). Up various portions cincts or best treatment.

**TRAINING.** 61 new employees trained in regular MCWA to part time Program.

**MAPS.** Maps Program use were fore tracings were made of ed in the field. The accuracy in a saving in erage of areas

**SPRAYING.**

1945, an average efited by the with DDT. This gallons of 3 29,500 man-hours concentrate and

**LARVICIDAL** gram larvicid mitted and ap cities in Ex So far, it ha to larvicida city having a the remaining a total popul entomological

**MALARIA PI** 208,650 resid bama are rece in one form o Program opera yet availabl been well rec effectiveness



re treatments with  
green, requiring

0 acre treatments  
gallons of oil at  
33 man-hours.

ILLANCE. The re-  
war areas were  
surveillance. The  
nd area personnel  
83 mosquito col-  
ing the year. Of  
stations or 0.7%  
r more *Anopheles*  
ree consecutive  
to ten *A. quad-*  
ected from eight  
r similar periods

the request of  
ssion, investi-  
proposed sites  
mps, and repre-  
e Office accom-  
boards on final  
ement has proven  
rol other than  
ce has not been  
selected under



as an available

## EXTENDED PROGRAM

In January 1945, the State Health Officer received authority to proceed with the organization of the Extended Program in Alabama. Six counties having the highest malaria mortality rate were selected for participation. These were: Autauga, Montgomery (Area 2), Dallas, Lowndes (Area 8), Marengo and Greene (Area 23). Upon the basis of the malarious portions of each county, 62 precincts or beats were approved for DDT treatment.

**TRAINING.** During February and March, 61 new employees were processed and trained in residual spraying while 4 regular MCWA employees were assigned to part time duty on the Extended Program.

**MAPS.** Maps suitable for Extended Program use were not available. Therefore tracings from aerial photographs were made of the 62 precincts and checked in the field as a part of the operation. The accuracy of these maps has resulted in a saving in time and in complete coverage of areas designated for treatment.

**SPRAYING.** From April 1 to June 30, 1945, an average of 97,500 persons benefited by the spraying of 17,400 houses with DDT. This required a total of 2,500 gallons of 35% DDT concentrate and 29,500 man-hours, or 0.144 gallons of concentrate and 1.70 man-hours per house.

**LARVICIDAL PROJECTS.** Extended Program larvicidal projects have been submitted and approved for seven towns and cities in Extended Program counties. So far, it has been necessary to resort to larvicidal operations in only one city having a population of 2,800 while the remaining six towns and cities with a total population of 108,350 are under entomological surveillance.

**MALARIA PROTECTION.** Approximately 208,650 residents of the State of Alabama are receiving malaria protection in one form or another through Extended Program operations. The results are not yet available but DDT spraying has been well received and reports of its effectiveness are quite optimistic.

## AEDES AEGYPTI

**ORGANIZATION.** An *Aedes aegypti* unit was in continuous operation in the city of Mobile during the year. An average of 11 persons was employed including a supervisor, assistant supervisor, inspectors, and a clerk-stenographer.

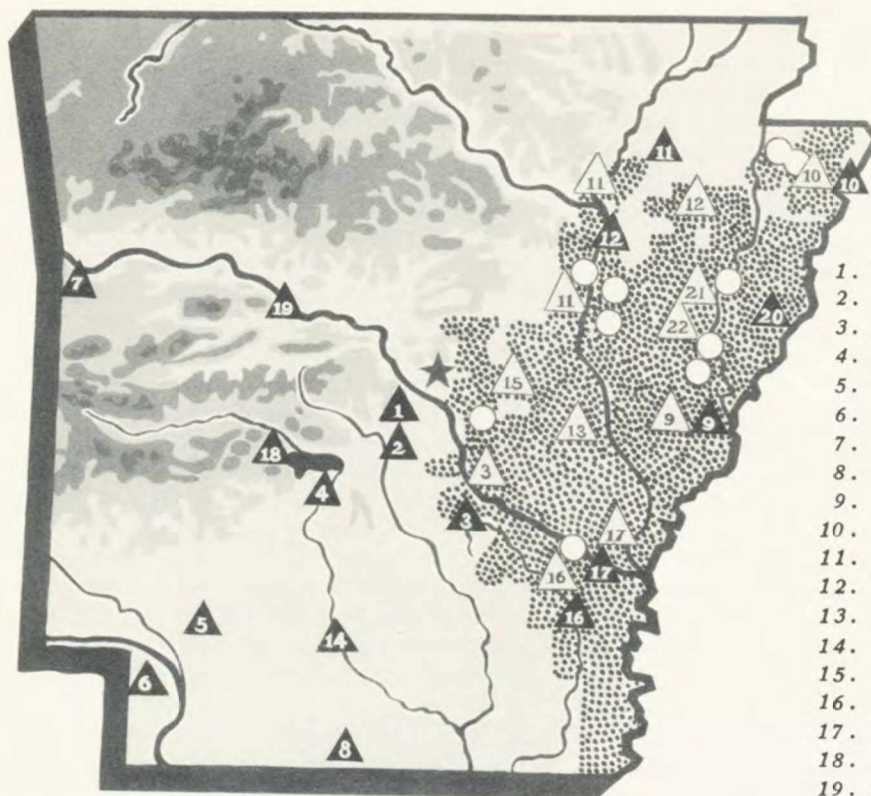
**EDUCATION.** Inspections were made of 81,427 residential premises while the Program was publicized through 137 news articles, 52 talks and 161 radio announcements. Industrial and non-residential premises also received attention, and assistance was given in making a sanitary survey of the city of Mobile in conjunction with *aegypti* control.

**RESULTS.** Rubbish collection and disposal was considerably improved as a consequence of control activities. Although there was no basis for comparison, it was felt that the *aegypti* breeding index for the summer of 1944 was substantially lower than that of previous years.



MOBILE, ALABAMA. Inspector recording results of findings. Inspections were made of 81,427 residential premises.





#### LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

The Arkansas MCWA program operates under the authority of the State Health Officer as a division of the Bureau of Sanitary Engineering. Its work throughout the State is organized under six divisions: Engineering, Operations, Equipment and Supply, Administration, Entomology, and Education.

MCWA operations were organized in 43 areas adjacent to military establishments and in 15 areas around defense plants. Operations were also set up in recreation and housing areas.

The Extended Program was put into operation in civilian areas of 18 Arkansas counties where malaria rates were highest.

#### ENTOMOLOGICAL INSPECTION

Eight hundred adult mosquito catch stations were examined weekly by entomological inspectors. When an "A" or "B" station showed a higher count than 10, the zone was considered out of control and an immediate search was made for the breeding source. Such counts

#### PROJECTS

1. Little Rock
2. Benton-Bauxite
3. Pine Bluff
4. Malvern
5. Hope
6. Texarkana
7. Ft. Smith
8. El Dorado
9. Helena
10. Blytheville
11. Walnut Ridge
12. Newport
13. Stuttgart
14. Camden
15. Lonoke
16. Jerome
17. Rohwer
18. Hot Springs
19. Russellville
20. Marion
21. Wynne
22. Forrest City
- ★ Little Rock

# ARKANSAS

**T. T. ROSS, M.D.**  
State Health Officer



ANOPHELINE BREED  
holes, and lakes

indicated that  
had come into p  
viciding was inc  
Eleven light  
tion in addition  
the Army. For th  
located in area  
been available

LA  
Larviciding  
of war area zc  
towns in counti  
tended Program.

Excessive rai  
floods created  
which had not  
when operation  
Receding flood  
of water caught  
and lakes. Much  
in locating and  
such breeding

In hilly sec  
good, larvicid





**ANOPHELINE BREEDING PLACE.** Much time was spent in locating and larviciding sloughs, sink holes, and lakes caused by receding flood waters.

indicated that a new breeding place had come into production, or that larviciding was incomplete or ineffective.

Eleven light traps were in operation in addition to several loaned to the Army. For the most part, traps were located in areas where records had not been available previously.

### LARVICIDING

Larviciding was done in a majority of war area zones and in the larger towns in counties included in the Extended Program.

Excessive rainfall and four successive floods created many new breeding areas which had not been estimated as such when operational plans were set-up. Receding flood waters left many acres of water caught in sloughs, sink holes, and lakes. Much time was spent, first, in locating and, then, in larviciding such breeding areas.

In hilly sections where drainage was good, larvicidal costs were \$600 per

square mile. Increased water surface and extensive clearing and major drainage necessary in flat, poorly drained sections made costs average \$947 per square mile in such areas.

Shifting of military personnel from the State allowed discontinuance of several war area control zones during the season.

### AIRPLANE DUSTING

Airplane dusting with a mixture of paris green and soapstone was used to control anopheline breeding in rice fields in the Walnut Ridge and Newport areas and in a 45-acre rice field in the vicinity of a POW camp at Harrisburg. This dusting was done at five-day intervals although original plans called for dusting every seven days. Approximately one pound of paris green was applied per acre.

Although it was felt that effective dusting was being achieved in the vicinity of the POW camp at Harrisburg,



work was discontinued in August when a change was made to DDT residual interior spraying of the camp.

It is believed that complete control of anopheline breeding in rice fields cannot be obtained by airplane dusting with paris green, and DDT is being used experimentally.

#### EXTENDED DDT PROGRAM

The DDT house spraying in civilian areas of the 18 Extended Program counties had a dual purpose: eradication of existent malaria and maintenance of a low malaria rate against the threat of increased spread from service men returning from malarious war areas.

A total of 87,211 houses were sprayed by 58 three-men crews working in the 18 counties. These crews were composed of two sprayers and a lead man. The lead man preceded the crews to see that houses were ready for spraying, and talked to the occupants about the purpose of the house spraying program and its func-

tion in malaria control. When the program was inaugurated, people were not well informed of its purpose and in some instances, the crews had to assist in moving furniture before houses could be sprayed. The number of people refusing to have their houses sprayed was negligible. Most of those who refused at first, later asked the supervisors to spray their houses.

Larviciding was used as a control measure in thickly populated areas and towns in the Extended Program.

**EQUIPMENT.** When spraying operations started in March, spray and automotive equipment were not available from headquarters' office. Spray cans had to be bought locally, and transportation shortages met by use of private trucks, wagons, and bicycles. Several spray crews began operations on foot, carrying spray equipment from house to house.

When adequate transportation was available, weapon carriers and reconnaissance cars were assigned to the



AIRPLANE DUSTING of rice field at Walnut Ridge, Arkansas. Dusting was done at 5-day intervals with approximately 1 pound of paris green being applied per acre.

spray crew with cover for too carrying s had 55-gall ed in mixi

Respira supplied t carded by perature

**TRAINING ACTIVITIES** strict men in sprayin viciding a trol opera trained c lectures

Public tended Pro of radio leases, and group spraying radio tin newspaper paratory "Spray T Time Top men of sp DDT Spr person w rious fa the publ ular le gram as material

Two m ties by Malaria of their They were and were long ran promotio ed Progr schools farm or various

Thre educati year: o



he program  
not well  
in some  
assist in  
ses could  
people re-  
sprayed was  
o refused  
pervisors

a control  
areas and  
m.  
operations  
utomotive  
rom head-  
had to be  
ion short-  
cks, wag-  
ray crews  
carrying  
o house.  
tion was  
nd recon-  
ed to the



at 5-day

spray crews. Each vehicle was fitted with cover cloths and an Army foot locker for tools. Many cars had racks for carrying spray cans and hose, and most had 55-gallon drums to carry water needed in mixing DDT concentrate.

Respirators and rubber gloves were supplied to all crews, but were discarded by most of them as summer temperature increased.

**TRAINING, PUBLICITY AND EDUCATIONAL ACTIVITIES.** Area supervisors and district men were trained at Little Rock in spraying procedures as well as larviciding and all phases of malaria control operations. These people in turn trained crews. Film strips, movies, lectures and demonstrations were used.

Publicity for promotion of the Extended Program was carried out by means of radio broadcasts, periodic news releases, distribution of literature, and group meetings in communities where spraying was to be done. Two hours' radio time and 1,200 column inches of newspaper publicity were utilized. Preparatory to spraying 37,000 copies of "Spray Time" (a modification of "Spray Time Topics") were distributed. Lead men of spray crews gave a copy of "How DDT Spray Keeps Malaria Away" to each person whose house was sprayed. Various farm organizations assisted in the publicity by mailing 33,000 circular letters regarding the spray program as envelope stuffers with their material.

Two men, employed in other capacities by MCWA, were selected to act as Malaria Control Assistants on the basis of their apparent aptitude for the work. They were given a ten-day training course and were assigned to carry out general long range malaria control education and promotion of the program in the Extended Program counties. Work was done in schools, with county health units and farm organization personnel and with various other community organizations.

Three workshops in malaria control education were conducted during the year: one at the Agricultural and Me-

chanical College at Monticello, one at the State Teachers College at Conway and one at the Agricultural-Mechanical and Normal College at Pine Bluff. These workshops were designed to give teachers the basic facts about malaria and its control and to present methods for malaria control education suitable for use in the classroom.

#### PROMOTION OF MALARIA CASE REPORTING.

In attempting to intensify malaria control around actual malaria cases and to encourage better reporting of malaria, all houses where diagnosed and reported cases of malaria occurred, were sprayed with DDT. In addition to house spraying, the patients were visited by the Malaria Control Assistants who inspected the premises and made recommendations for mosquito-proofing and destruction of breeding places. In the spring of 1945 until June 30, 72 cases were visited twice. The second visit was made 30 days after the original inspection to determine to what degree recommendations had been followed.

County health authorities were contacted regarding physicians' reporting malaria. A letter was sent to physicians explaining the program and the part that routine blood smears could play in furthering the work. To facilitate the physicians' sending blood films to the State laboratory for examination, slides and special mailing containers were given to the doctors.

The objectives of this Program were: (1) to induce people to call doctors, (2) to arouse the doctors' interest and encourage the taking of blood films and (3) to obtain more complete case reporting.

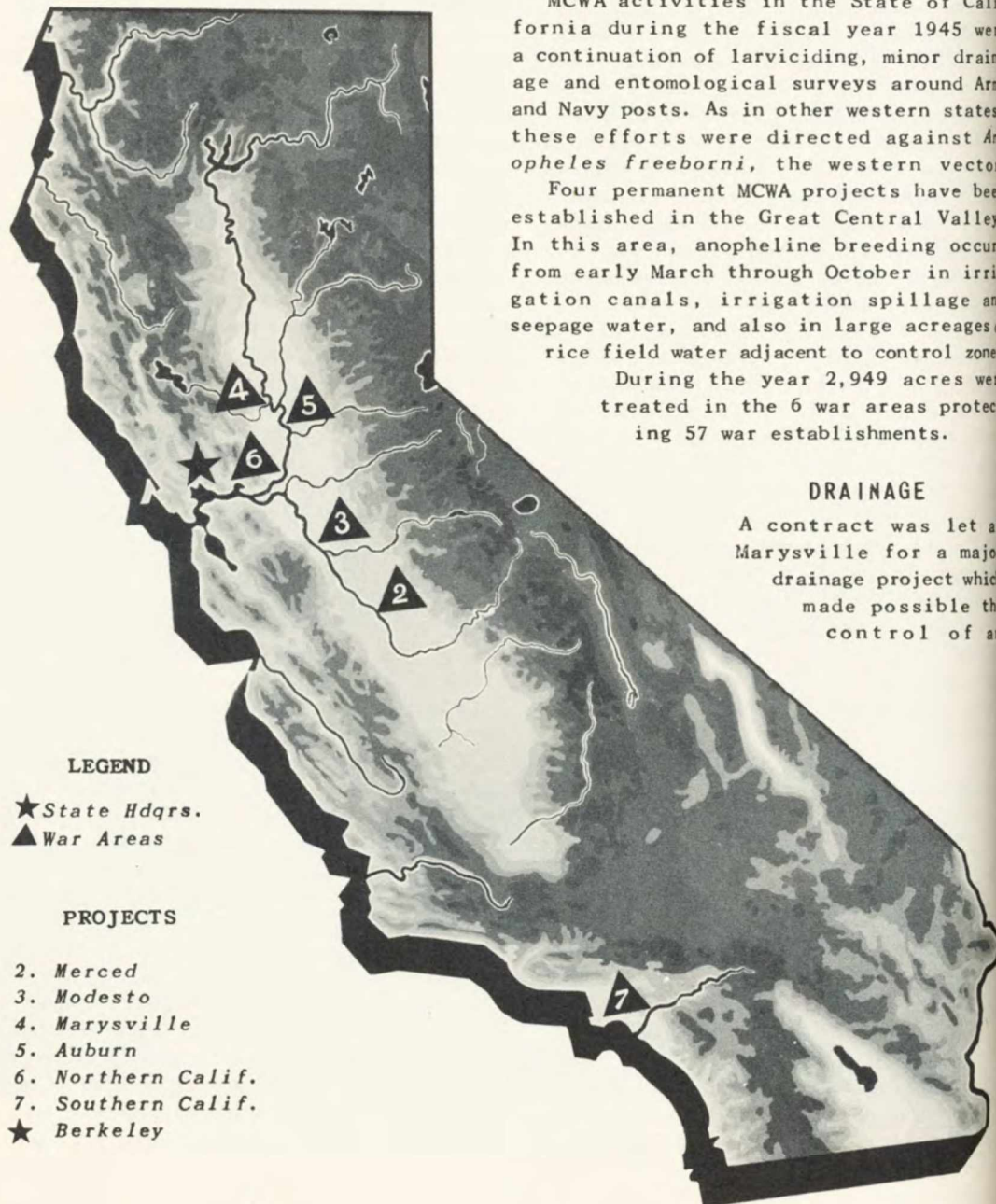
**PRESENT PROPOSALS.** Present proposals include the spraying of 102,000 homes in 22 counties. Twelve of these counties will be sprayed county-wide while the other ten will be less than county-wide. The limits of operation were determined by the extent of delta flood plains of the White River and Red River Valley.



# CALIFORNIA

WILTON L. HALVERSON, M.D.

State Health Officer



MCWA activities in the State of California during the fiscal year 1945 were a continuation of larviciding, minor drainage and entomological surveys around Army and Navy posts. As in other western states, these efforts were directed against *Anopheles freeborni*, the western vector.

Four permanent MCWA projects have been established in the Great Central Valley. In this area, anopheline breeding occurs from early March through October in irrigation canals, irrigation spillage and seepage water, and also in large acreages of rice field water adjacent to control zones.

During the year 2,949 acres were treated in the 6 war areas protecting 57 war establishments.

## DRAINAGE

A contract was let at Marysville for a major drainage project which made possible the control of an

area which formed a breeding. A dragline was used in grading to grade 10' irrigation drainage canals. Soldiers-of-war were contract with the War and burning trees and brush as well as fences and bridges. The cost of many acres of land confined the irrigation a definite canal.

**PUMP.** The Merced to considerable a contractor's type centrifugal pump, mounted on a trailer and towed by truck. The fact that the pump has made it possible for many low area zone below the high by irrigation canals are gradually re-irrigation water adjacent crops and irrigation canals, periodically throughout the season.



A 20,000 GPH centrifugal pump is used to pump water into nearby irrigation canals.



State of California year 1945 were minor drainages around Army western states, against An- eastern vector. Projects have been Central Valley. Breeding occurs October in irrigation spillage and large acreages of to control zones. 949 acres were r areas protect- ishments.

#### AINAGE

act was let at le for a major ge project which e possible the onrol of an

area which formerly offered extensive breeding. A dragline was used in excavating to grade 10.5 miles of existing irrigation drainage ditches. Fifteen prisoners-of-war were employed under contract with the War Department for cutting and burning trees and accumulated debris as well as for rebuilding fences and bridges. The completed project drained many acres of standing water and confined the irrigation drainage within a definite canal.

**PUMP.** The Merced area has utilized to considerable advantage a 20,000 GPH contractor's type motor-driven centrifugal pump, mounted on a two-wheeled trailer and towed by a one-half ton truck. The fact that this pump is mobile has made it effective in drainage of many low areas within the control zone below the high water level in nearby irrigation canals. Since these areas are gradually replenished by excess irrigation water overflowing from adjacent crops and by seepage from irrigation canals, pumping has been done periodically throughout the breeding season.



A 20,000 GPH centrifugal pump dewatering an area in Merced. Water is being pumped into nearby irrigation canal.

#### FLUSH DAM

An exception to the normal control methods was the construction and operation of a flush dam on a creek located within the control zone near a Naval establishment. Construction Battalion personnel from the Camp and MCWA labor performed the construction work.



CB's constructing flush dam in control zone around Naval establishment in Area 6.

#### UNDERGROUND DRAINAGE

In the Auburn area, the winter work of constructing numerous underground drains and open ditches materially reduced the amount of anopheline breeding found last season as compared with the previous season. A filler material of local broken rock was used successfully for the underground drains. Several small hand-operated flush dams installed on the creeks have also helped to reduce the breeding.

In the Modesto area the Irrigation District cooperated in replacing approximately two miles of open drainage ditches with underground pipe, thereby eliminating considerable breeding area.





SIMMERLY SLOUGH NEAR MARYSVILLE. (Above) A dragline was used in excavating to grade 10½ miles of existing irrigation drainage ditches. (Left) Simmerly Slough before drainage. This area offered extensive mosquito breeding.

Weed control  
taylor phen  
cessfully ac  
or irrigatio  
lution of pe  
fuel No. 2 v  
tion of the  
of pentachl  
square foot  
made at abo  
each time, p  
water level  
rarily lowe  
This work v  
with the I  
particularly  
tion canals  
main breed

An unus  
*freeborni*  
tion of the  
to Birming  
satisfactor  
dusting at

ENTOM  
MOSQUIT  
adjacent t  
tral Valle  
viciding a  
fective job  
population  
However, c  
months, beg  
ing until  
females se





## HERBICIDES

Weed control by application of pentachlorophenol as a herbicide was successfully accomplished along the banks of irrigation canals. A 0.5 percent solution of pentachlorophenol in Diesel fuel No. 2 was sprayed on the vegetation of the canal banks so that 18 grams of pentachlorophenol were applied per square foot. Three applications were made at about six-week intervals and each time, prior to the application, the water level in the canals was temporarily lowered approximately two feet. This work was done in collaboration with the Irrigation District and is particularly significant as the irrigation canals in this area constitute the main breeding problem.

## AIRPLANE DUSTING

An unusual condition of *Anopheles freeborni* breeding in a 60-acre section of the Los Angeles River, adjacent to Birmingham General Hospital, was satisfactorily controlled by airplane dusting at 0.1 pound of DDT to the acre.

## ENTOMOLOGICAL OPERATIONS

**MOSQUITO MIGRATION.** In most areas adjacent to rice culture in the Central Valley, control measures of larviciding and minor drainage do an effective job in reducing adult mosquito populations during the summer months. However, during the fall and winter months, beginning in September and lasting until February, counts of adult females seldom remain below 10 per sta-

tion in control zone resting places. This is due to the incredible number of mosquitoes produced in nearby rice fields. These mosquitoes migrate or move away from the fields due perhaps to overcrowding or a desire to seek shelters suitable for winter. This migration occurs each year, but the nature and cause are imperfectly known. It is not uncommon for good resting stations to have counts of 200 to 5,000 adult mosquitoes. Early in the fall there is a high proportion of males, about one-half, but by December they have diminished to only an occasional male. This migration has a direct bearing on the control problem because the greatest number of reported malaria cases occurs during fall.

**INVESTIGATION.** Beginning in September of 1944 in the Marysville-Winters areas some investigational work was done to obtain additional information on the flight range of *Anopheles freeborni* in areas where there is extensive rice growing. Adult collecting stations extending from these rice field breeding areas were set up for a distance of about five miles. From consecutive adult counts at these stations, it soon became apparent that the fall migration had been in progress for several weeks prior to the start of the investigation. Evidence collected indicated that at this time of the year, some of the adults fly at least five miles. A further study of this problem will be continued in the fall of 1945 beginning early enough to complete the investigation.

Artificial pond producing anophelines at Auburn (Area 5).



NEAR MARYS-  
dragline was  
to grade 10½  
irrigation  
(Left) Sim-  
re drainage.  
d extensive



Careful records were kept of adults found in resting places near rice fields in the Merced area for the entire year. These indicated a heavy population in shelters from mid-July until February when they dispersed in search of blood meals to be followed by egg laying.

**NATURAL RESTING PLACES.** Routine inspection records on *A. freeborni* in areas where breeding is occurring, show an absence of adults in nearby natural resting places during the summer. To account for this, a study of the resting habits of this species is being made in the Auburn area. Artificial resting places (apple boxes painted black) are being used in conjunction with established natural resting places so that the two types may be compared. These artificial resting places were located at intervals along lines radiating away from the breeding areas. This work is continuing and it is hoped that conclusions may be made by the winter of 1945 in regard to some of the habits of the adults during the summer.

**SOUTHERN CALIFORNIA.** In comparison it has been noted generally that the population density of adults is considerably lower in Southern California than in Northern California. The fall migration of the adults into all types of man-made shelters in the Northern California zones has not been observed in the Southern California zones. In some zones of this area, breeding is apparently continuous throughout the year, as evidenced by the finding of larvae and male, as well as female adult forms during the winter months.

**MOBILE UNIT OPERATIONS.** A total of 20 military zones were included in the MCWA operations of the Northern and Southern California Mobile Malaria Control Units during the 1945 fiscal year. Operations in these zones were on both a surveillance and control basis and included Navy and Army hospitals and training bases, Army airfields and POW camps.

Species control was carried out in the extra-cantonment area of 11 zones by the mobile unit personnel. Hand dusting with paris green was the usual larviciding method employed.

#### DDT SPRAYING

In December of 1944, selected buildings except dwellings in the one-mile control zone around the Army airfield at Merced, were sprayed with DDT in order to study its effects on the hibernating *A. freeborni* adults. Before spraying, the buildings were surveyed for adults, mapped, and their surface areas computed.

In addition to a solution of DDT in Diesel fuel No. 2, two commercial DDT products were used with 1% refined summer oil. Straight Diesel fuel No. 2, and 1% summer oil were also applied as controls.

On the basis of surface areas sprayed and amounts of each material used, the concentration of DDT in milligrams per sq. ft. was: DDT and Diesel fuel No. 2, 160; commercial DDT product No. 1, 1.3; commercial DDT product No. 2, 1.4.

All materials were applied at the rate of approximately 5 cc. per square foot of surface using a 50-gallon orchard type power sprayer.

Periodic adult population checking in both the treated and untreated buildings was continued through the end of February 1945. These data showed that for this entire period, all three DDT mixtures, as well as the Diesel fuel, reduced the adult population nearly to zero. This was in contrast to populations averaging 40 adults per station in the untreated area and that sprayed with 1% summer oil.

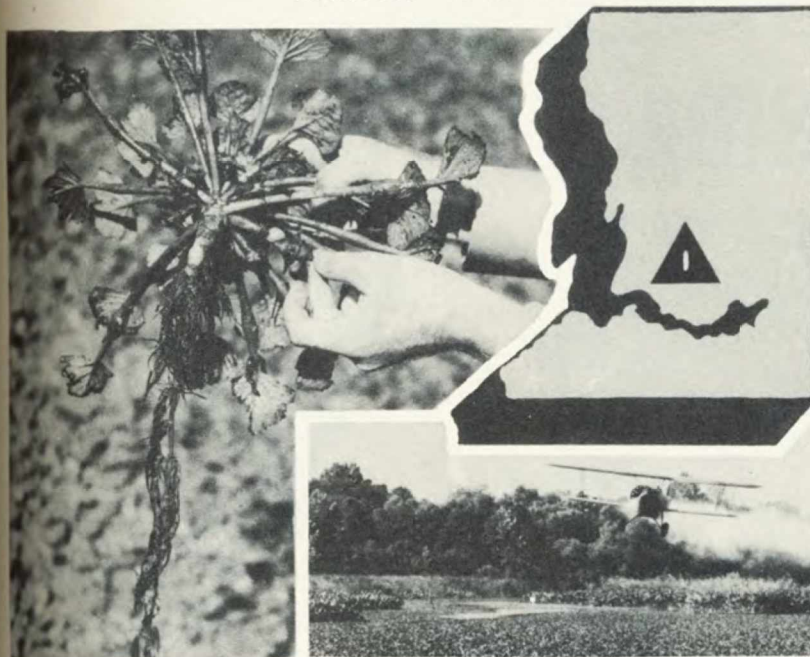
In view of the migration habits of *A. freeborni* and the results of the DDT work at Merced, DDT residual spraying projects in the Marysville and Merced areas will be undertaken during the fall of 1945 in an attempt to cope with the fall migrations of adults into the control zones from the rice field breeding areas outside.



# DISTRICT OF COLUMBIA

GEORGE C. RUHLAND, M. D.

District Health Officer



## LEGEND

▲ War Area\*

\*The 69 miles of the District of Columbia compose one War Area.



During the past fiscal year the District of Columbia MCWA program stressed entomological surveillance rather than control. The shift in emphasis was made possible by the removal, during the previous year, of the water chestnut from Oxon Run.

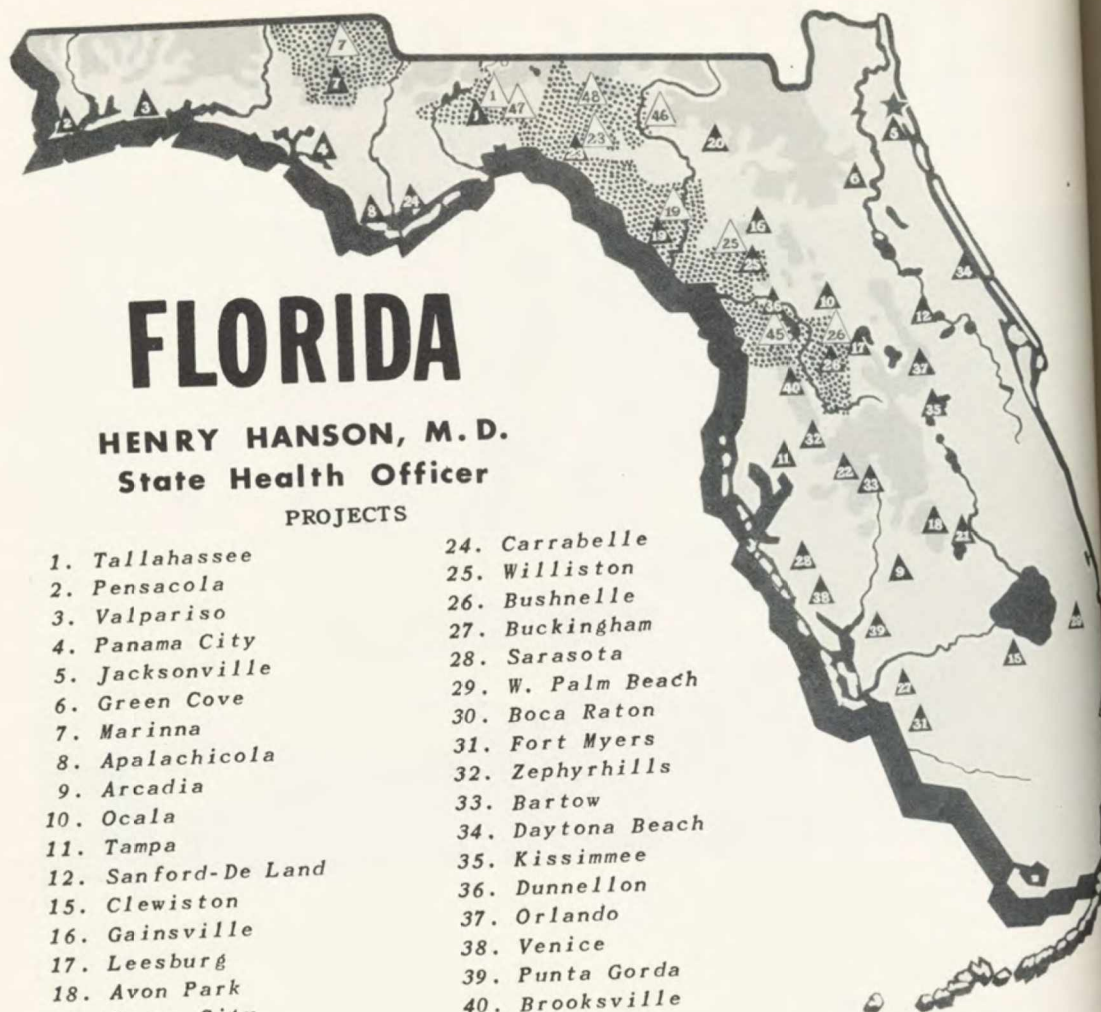
## INTEGRATION WITH HEALTH DEPARTMENT

Mosquito control by agencies of the District of Columbia was expanded with the discontinuance of MCWA control activities. The MCWA work was transferred to the Bureau of Sanitation of the D. C. Health Department in January of 1944. This coordination led to the elimination or control of some of the

mosquito breeding places by private property owners through the use of police power of the Health Department over public nuisances. In a number of cases, orders from the Health Department were necessary to persuade property owners to eliminate breeding places located by the D. C. Health Department inspectors under MCWA supervision.

Inspectors of the Bureau of Sanitation have been trained in the technique of mosquito control so that they are able to report intelligently on mosquito nuisances discovered incidental to other work. In this way, anti-malaria and anti-mosquito work may be continued after the War through the Health Department Personnel.





# FLORIDA

**HENRY HANSON, M.D.**  
State Health Officer

## PROJECTS

- |                          |                   |
|--------------------------|-------------------|
| 1. Tallahassee           | 24. Carrabelle    |
| 2. Pensacola             | 25. Williston     |
| 3. Valpariso             | 26. Bushnelle     |
| 4. Panama City           | 27. Buckingham    |
| 5. Jacksonville          | 28. Sarasota      |
| 6. Green Cove            | 29. W. Palm Beach |
| 7. Marinna               | 30. Boca Raton    |
| 8. Apalachicola          | 31. Fort Myers    |
| 9. Arcadia               | 32. Zephyrhills   |
| 10. Ocala                | 33. Bartow        |
| 11. Tampa                | 34. Daytona Beach |
| 12. Sanford-De Land      | 35. Kissimmee     |
| 15. Clewiston            | 36. Dunnellon     |
| 16. Gainesville          | 37. Orlando       |
| 17. Leesburg             | 38. Venice        |
| 18. Avon Park            | 39. Punta Gorda   |
| 19. Cross City           | 40. Brooksville   |
| 20. Lake City            | 45. Citrus        |
| 21. Sebring              | 46. Suwannee      |
| 22. Lakeland             | 47. Jefferson     |
| 23. Perry ★ Jacksonville | 48. Madison       |

There was no visual or reported evidence of malaria transmission in the civilian population or in military areas under control in Florida during the past fiscal year. Minor drainage and larviciding were performed around 27 of the 38 war areas in the State. A major drainage project involving the use of dynamite was in progress in Lake City. However, there has been relatively little ditching during the past year whereas ditch maintenance has assumed greater importance.

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray

## LARVICIDING

Airplane dusting was utilized on large lakes in the Leesburg area. In West Palm Beach and Boca Raton, large canals were dusted with a power duster mounted on a jeep. This method has been found to be expedient as well as practical. Power dusting from a boat was

used in the Lake City effective.

Some ex-icides, us-dichloroph-effective water hy-serious pr-well as t

A comp-plication-tion cont-fifty gal-investiga-coming fi

Hydra-in the l-city of-complete-one of t-rimacula-city wil-inated.

RIGHT. W-spraying-acid. BE



Lake City areas, and likewise proved effective.

## HERBICIDES

Some experiments were made with herbicides, using a chemical compound of 2,4 dichlorophenoxy-acetic acid. This proved effective in combating the growth of water hyacinths, which has become a serious problem for malaria control, as well as to navigation and fishing.

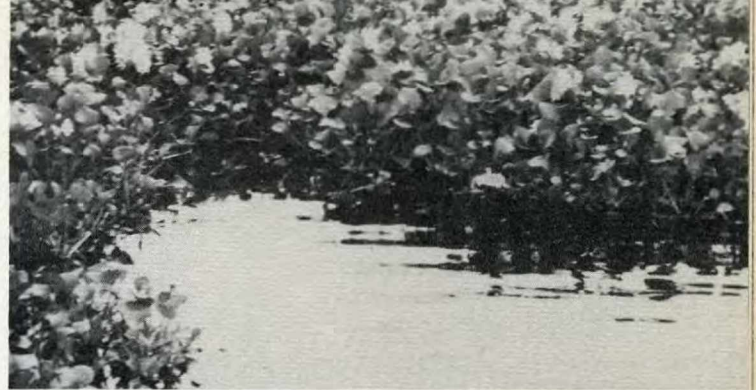
A complete kill was obtained by application with a hand sprayer of a solution containing one quart of 2,4-D. to fifty gallons of water. These herbicidal investigations will be continued in the coming fiscal year.

## HYDRAULIC DREDGING

Hydraulic dredging was continued in the large marsh area adjacent to the city of Leesburg. When this project is completed, possibly by the end of 1946, one of the most serious *Anopheles quadrimaculatus* breeding areas around the city will have been permanently eliminated.

---

RIGHT. Water hyacinths, before and after spraying with 2,4 dichlorophenoxy-acetic acid. BELOW. Application of the spray.





## DITCH LINING

Installation of permanent ditch lining is still in progress in the Leesburg and Gainesville areas. Both the city of Leesburg and the University of Florida are supplying materials, while MCWA is furnishing the supervision and labor required.

The work at Gainesville is being performed on the University campus where a malaria hazard exists. It is expected that the work will accomplish a two-fold purpose by eliminating the malaria hazard and by serving as a demonstration for the University in familiarizing the engineering students with the technical phases of permanent ditch lining for malaria control.

## DDT RESIDUAL SPRAYING

Ten counties were selected to receive residual house spraying with DDT during 1945. A house-to-house survey and mapping of these areas was completed throughout the winter months.

In Citrus County area, operations began March 1, 1945. In 9 other counties: Sumter (Area 26), Levy (Area 25), Dixie (Area 19), Suwannee (Area 46), Jefferson (Area 47), Leon (Area 1) and Jackson (Area 7), work was under way by

**AEDES AEGYPTI CONTROL.** (Left) *Aegypti* breeding places were cleared up in the course of general sanitary inspections. (Right) Window displays being prepared for exhibit.

June 30, although full operation was delayed in some areas due to lack of equipment.

During three months of spraying, houses which had been visited were averaging 3,200 square feet of interior wall space and each required the use of approximately 0.7 pounds of DDT. Altogether 7,720 houses were sprayed, giving protection to an average of 135,402 persons.

## EDUCATIONAL PROGRAM

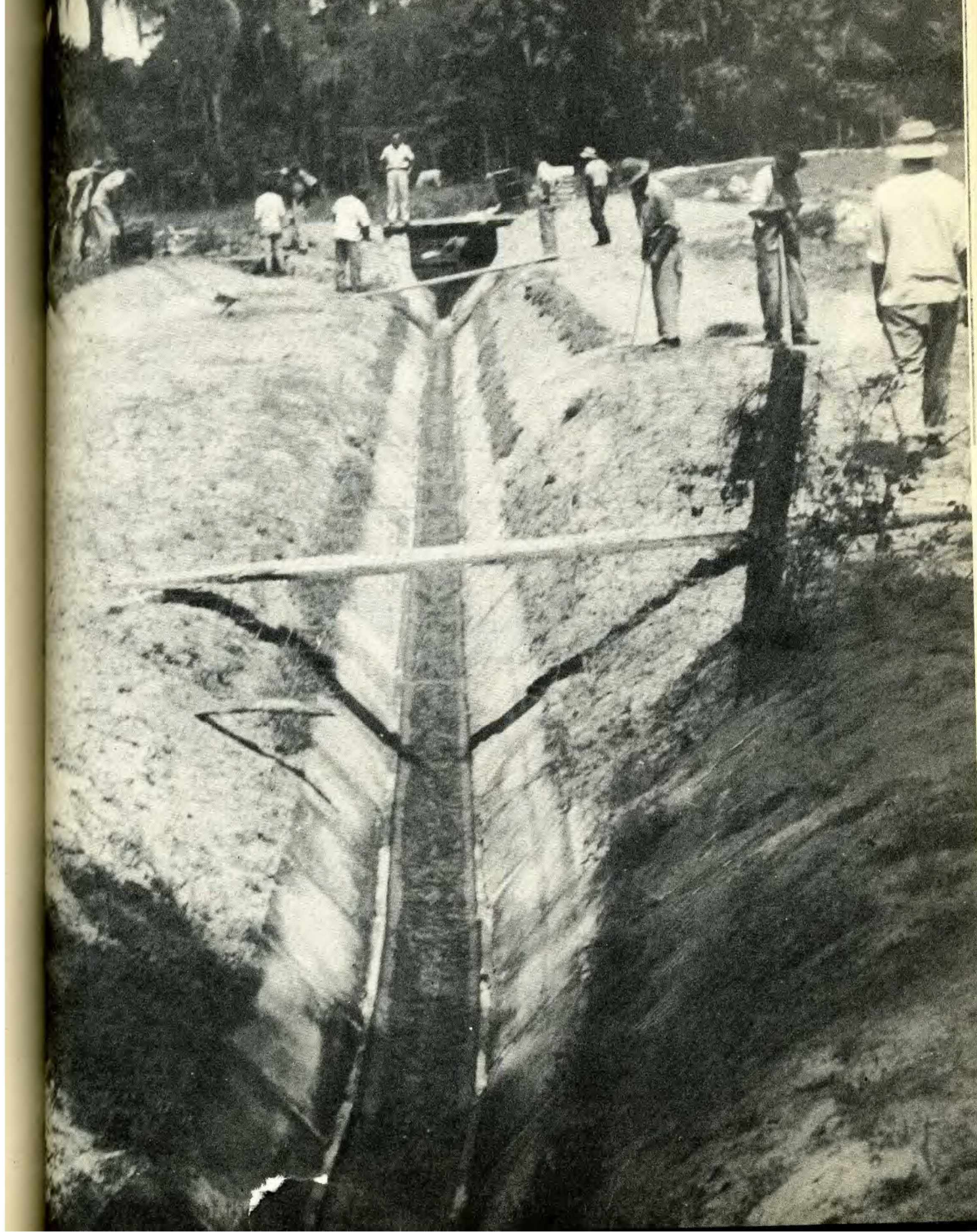
In conjunction with residual house spraying, an educational program was carried on to facilitate operations. In many civic clubs and possibly 30 schools, over 7,000 persons witnessed the animated short films: "Winged Scourge" and "Spray Time" and heard lectures on DDT house spraying. Several thousands of pamphlets on the subject were distributed.

## AEDES AEGYPTI CONTROL

In addition to the malaria control program, *Aedes aegypti* projects were in operation at Miami, Key West, Jacksonville, and Tampa. On these projects considerable stress was placed on educational work. It is felt that much progress was made in these cities.









# GEORGIA

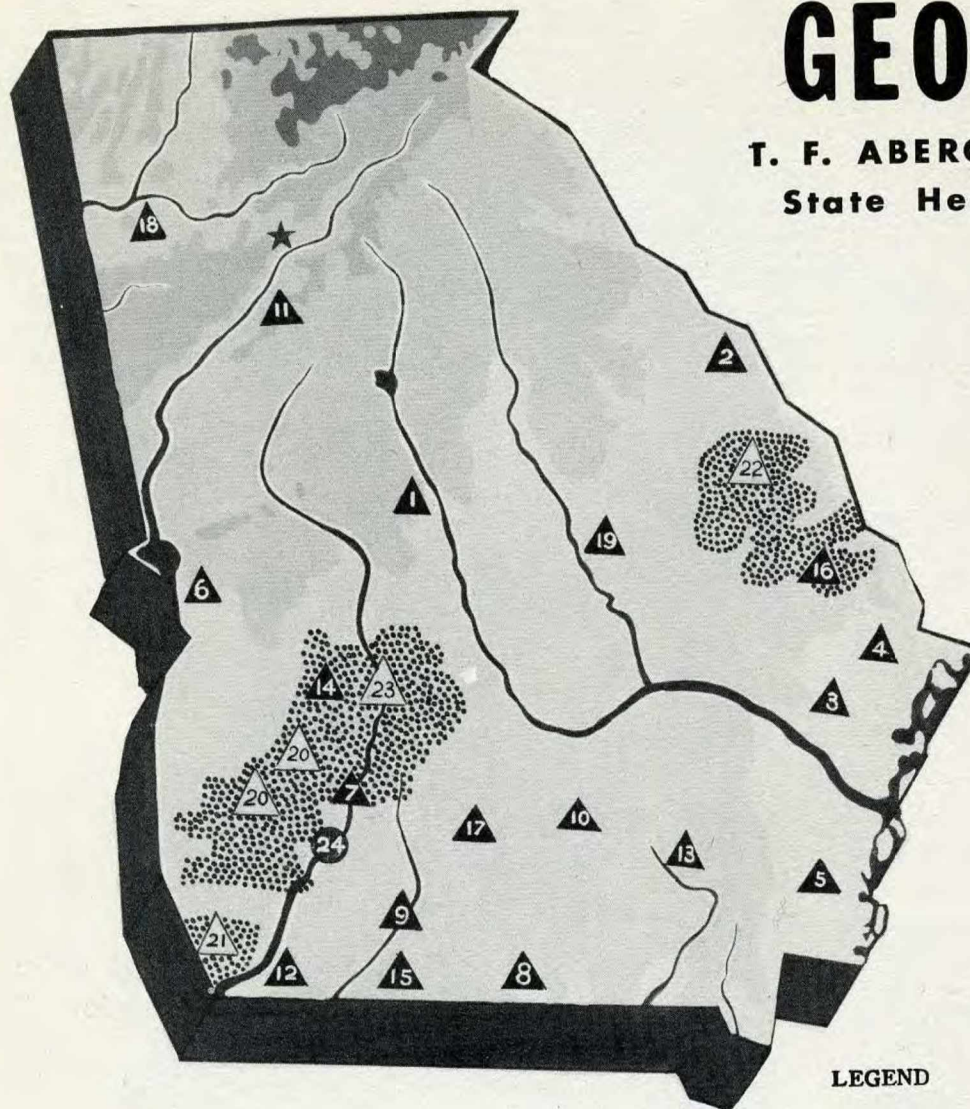
**T. F. ABERCROMBIE, M.D.**  
State Health Officer

## PROJECTS

1. Macon
2. Augusta
3. Hinesville
4. Savannah
5. Brunswick
6. Columbus
7. Albany
8. Valdosta
9. Moultrie
10. Douglas
11. Atlanta
12. Bainbridge
13. Waycross
14. Americus
15. Thomasville
16. Statesboro
17. Tifton
18. Rome
19. Dublin
20. Dawson
21. Donalsonville
22. Waynesboro
23. Cordele
24. Emory Field Station

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- Residual Spray
- ★ Atlanta



Reported malaria morbidity and mortality continued low in Georgia during the fiscal year 1945 as compared with previous years.

Total cases of malaria reported as occurring in the civilian population during the calendar year 1944, were 288 while 11,931 cases were reported in 1936. However, malaria morbidity reported during the first four months of 1945 was approximately twice that reported in the same period for 1944. This increase in reported malaria may

be due partly to natural causes but there is reasonable assurance that reporting of malaria has been stimulated by the inauguration of the Extended Program.

All MCWA activities were directed toward the control of the malaria vector. Larvicidal and minor drainage programs were conducted in 17 of the 19 war areas during the fiscal year. In four of these, operations have now been discontinued due to the cessation of war establishment activities.



**PARIS GREEN.** Paris green continued to be the main larvicide employed. Some 15,274 acres were treated during the year. With the exception of the Albany area, application was made by hand dusters. Power dusters operated from outboard motor-driven boats were used in cooperation with the Georgia Power Company's reservoir. This reservoir is adjacent to Turner Field Army Air Base and the USO recreation area.

**OIL.** Small amounts of Diesel oil were used in the vicinity of Army General Hospitals at Rome and Thomasville.

**DDT.** Some large scale experimental larviciding operations using DDT dust and DDT emulsions were conducted at Savannah in cooperation with the Carter Memorial Laboratory.

### OTHER CONTROL OPERATIONS

In the Albany area, controlled weekly fluctuation of the reservoir level was of considerable assistance in reducing breeding. During the winter, a topographic and hydrographic survey was made of the more critical areas of the reservoir and its shores. Landlocked pockets revealed by this survey will be drained.

**FILLING AND DRAINING.** Near Augusta, minimum level filling continued using waste brick plant products and minor natural hydraulic fill.

Lake Aumond, within flight range of Oliver General Hospital, developed heavy breeding which proved difficult to control. The lake owner was persuaded to drain the lake and to perform major shoreline and vegetation improvements around the lake. This eventually will eliminate or materially reduce the necessity for control measures.

**DYNAMITE.** Three tons of dynamite furnished by the Richmond County Commissioners, were used in the reconstruction of Phinizy Canal. Muck and debris, which dynamite did not remove

removed by use of a slip pan powered by a Command car winch.

**DREDGING.** In the Macon area, hydraulic dredging operations were completed in the Fuse Plant zone and were begun in the Camp Wheeler zone in cooperation with the Army. The four-inch dredge was further modified. Its cost of operation compared favorably with dynamite, dragline or other mechanical methods of excavation.

**DRAINAGE.** Victory Lake on the Berry Schools property, at a distance of about 1.1 miles from Battey General Hospital (Rome area), developed into a heavy breeder. The lake is being drained, shallow areas will be eliminated, and a new drainage outlet constructed in cooperation with the Berry Schools.

**TIDEGATES.** Control operations have been materially improved in the Quartermaster zone near Savannah through Chatham County's reconstruction of the Pipemakers Canal Tidegates. These gates are counterweighed so that less than 0.1 foot head is required to close them. Most of the abandoned rice fields, adjacent to the canal, remain dry under normal conditions. A topographic survey, using the transit plane table method, was of considerable assistance in laying out the drainage system so as to effectively utilize the tidegates in maintenance of low stages in the Canal.

**DITCH PAVING.** At Statesboro, approximately one-third mile of invert paving was installed, using circular side joint slabs, 10 inches wide and 36 inches long. Butt-joint tile and single flat slabs were used in tributary laterals. Bulloch County and the city of Statesboro provided all materials for the ditching, paving and butt-joint tile installations.

**TOPOGRAPHIC SURVEY.** A topographic survey of an area in the Moody Field-Valdosta zone, located the probable source of heavy breeding. Considerable dewatering was effected in this area by minor drainage.



## EXTENDED PROGRAM

**AREAS.** Extended Program operations were initiated in Seminole County on March 14, 1945. Four areas, totaling all or portions of 11 counties, are now in operation and plans have been made for coverage of portions of two additional counties, which will be incorporated in existing areas.

**PERSONNEL.** All area operations were conducted under the general supervision of the area supervisor. In multiple county areas, each county's operations were closely supervised by a county supervisor. Other county personnel included an assistant, one or more sprayers and one or more laborers.

**EQUIPMENT.** Spray crew vehicles were equipped for all weather operations. Practically all equipment maintenance was performed within the county or area.

**HOUSEHOLD PREPARATION.** The county assistants were responsible for dissemination of program information to the public and for securing the cooperation of individual householders.

The assistants contacted householders, advising as to house preparation and

approximate time of arrival of the spray crew. If the householder did not agree to the spraying of the house or if house preparations were not substantially complete when the spray crew arrived, the house was not sprayed.

It was estimated that 12,501 houses were sprayed, protecting approximately 91,863 persons.

**SUCCESS OF PROGRAM.** To date, there have been extremely few complaints, none of which were serious, from residents of houses sprayed. In fact, residents and governmental officials of nearby areas which are not in the Extended Program, were extremely anxious to have their dwellings sprayed.

Several counties agreed to furnish personnel and equipment in order to secure participation in the program.

From the general public's viewpoint, this program is one of the most beneficial proposed or conducted by public health organizations. It is believed that with this stimulation of interest organized health departments in every county of the State may begin operation at an earlier date than has been heretofore expected.



PIPEMAKERS CANAL, CHATHAM COUNTY. Control operations have been greatly improved by modification of existing control tidegates which are counterweighed so that less than 0.1 foot head is required to close them.

Courtesy of the David J. Sencer CDC Museum



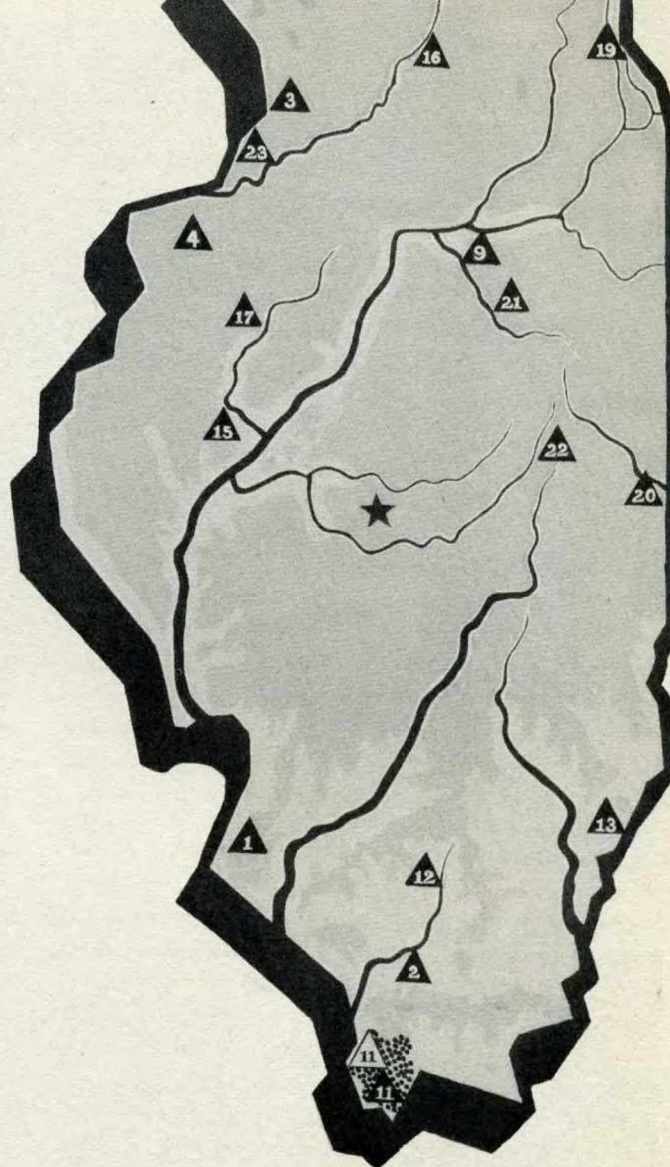
**ROLAND R. CROSS, M.D.**  
State Health Officer

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray

## PROJECTS

1. East St. Louis
2. Ill. Ordnance Plant
3. Savanna
4. Rock Island
9. Seneca
11. Cairo
12. Mt. Veron
13. Lawrenceville
15. Table Grove
16. Rockford
17. Galesburg
19. North Chicago
20. Danville
21. Dwight
22. Rantoul
23. Schick
- ★ Springfield-Decatur



The Illinois MCWA program followed the same pattern during the past fiscal year as during the previous year. The problem was primarily one of surveillance except in the southern part of the State where control projects were in operation. Surveillance was maintained in 13 zones of primary installations throughout the State.

Entomological data at certain times during the season indicated that a few zones were on the border of requiring control. Close cooperation with military officials with respect to entomological findings made it possible to evaluate needs for control measures with full knowledge of local situations.



## ENTOMOLOGICAL PROGRAM

The entomological program was designed to collect data on the incidence of *Anopheles quadrimaculatus* in as many locations as possible. These data were of particular importance because of the redistribution of malaria carriers throughout the State as a result of war activities. The malaria vector is distributed generally throughout the State but the malaria rate was very low during the pre-war period.

With personnel of the State MCWA program and mobile units available from the District and Headquarters office, prompt action could be taken in the event of an outbreak of malaria.

The value of the program can be weighed by the fact that there were no cases of reported malaria caused by local transmission from military installations and prisoner-of-war camps to local populations during the year.

Malaria control surveys were made in 13 zones at POW side camps, minor military installations, Army general hospitals and Veterans Administration hospitals.

The selection of POW side camp sites was made in locations practically free of potential "quad" production, with the exception of one at Hoopston (Area 20) where two ponds on the boundary line of the reservation were handled by military officials.

Surveys were made at sites of Veterans Administration hospitals because of reported malaria cases during the previous season and the expected increase of malaria among patients.

Twelve zones previously set up as part of the Illinois MCWA program were dropped during the past fiscal year, as a result of changed conditions.

## LARVICIDAL CONTROL

Larviciding was performed in five zones in two areas in the southern part of the State during the 1944 season. This control was reduced to three zones with the opening of the 1945 season because of reduced war activities.

During the year 7,690 acres were treated around 80 war establishments in the 16 war areas throughout the State.

Plane spreading a mixture of paris green and lime. In the Illinois Ordnance Plant area this method was employed and proved more satisfactory than surface power spraying.







Silver Creek bottoms during seasonal floods. This Creek has long been a problem and it is believed that extensive drainage would prove to be the most effective means of control.

### AIRPLANE DUSTING

In the Illinois Ordnance Plant area, the method of control was changed from the use of surface power equipment to airplane dusting. The latter method proved more satisfactory than treatment with surface equipment. In the late summer an extreme drought in this zone changed conditions of the breeding areas, so that it would have been almost impossible to maintain control with surface equipment because of shallow water.

At all times during the control season "quad" counts were maintained at safe levels and it is therefore planned to continue this method of control during the 1945 season.

### DRAINAGE

The main problem in the Scott Field zone (Area 1) was the Silver Creek bottom lands. It is believed from the experience of the past two seasons that more economical and efficient control will be possible if extensive drainage is performed. Several times during the season, the creek rises because of sum-

mer rains, and re-establishes extensive breeding areas in these bottom lands.

Plans have been made and work is now under way to install large ditches which will give direct fluctuation of breeding areas with the water levels in the creek.

Previously, it has been impossible to undertake drainage because of conservation interests. However, when the extreme drought in September of 1944 destroyed all fish in the sloughs, ditches could be installed to keep these sloughs dry.

### DDT SPRAYING

A residual spray project using DDT was put in operation in Alexander County. Although comparatively small, this project gives public health officials an opportunity to study the use of DDT in rural malaria control. Experience gained from this project will be very valuable to public health officials when this chemical becomes available for more general use.



# INDIANA

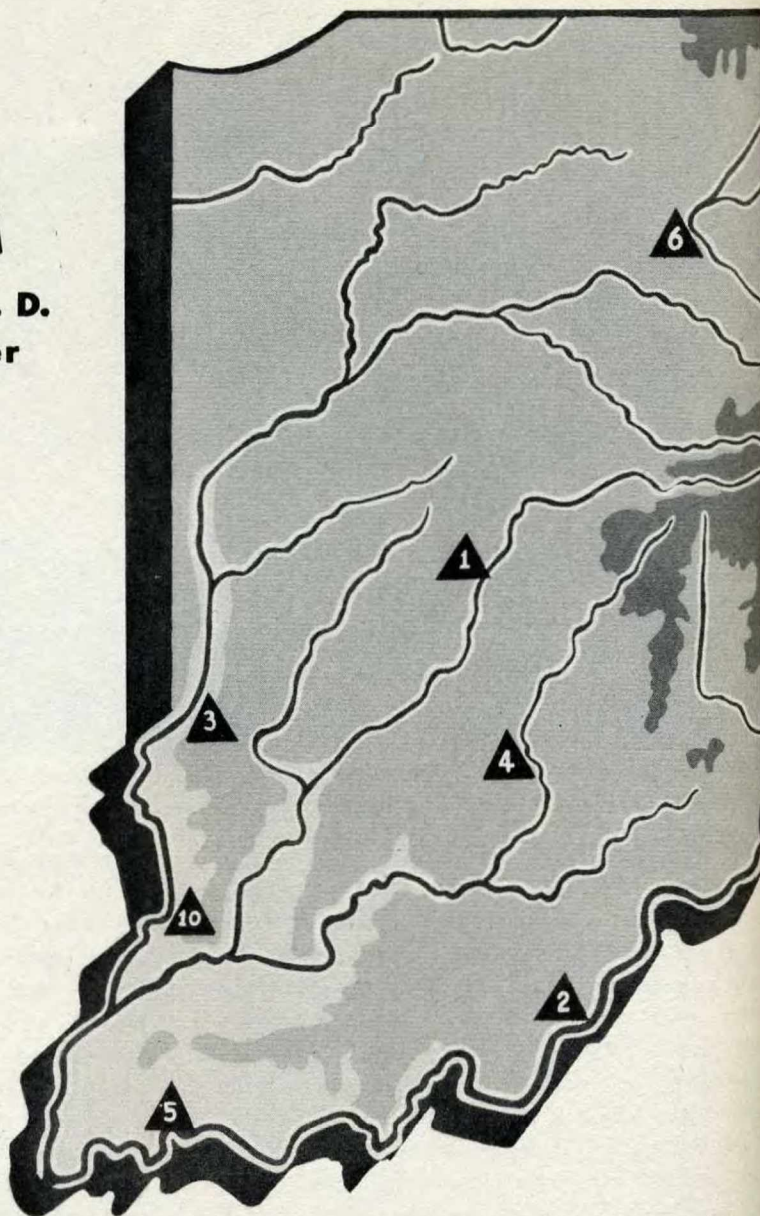
THURMAN B. RICE, M. D.  
State Health Officer

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas

## PROJECTS

1. Indianapolis
2. Jeffersonville
3. Terre Haute
4. Columbus
5. Evansville
6. Fort Wayne
10. Vincennes
- ★ Indianapolis



In the State of Indiana, the areas emphasized in malaria control have been Terre Haute on the Wabash River, Evansville on the Ohio River, and Indianapolis on the White River.

Surveillance has been maintained in five other areas around military establishments in various parts of the State where *Anopheles quadrimaculatus* densities were found to be too low during the 1944 breeding season to warrant control.

## TERRE HAUTE

**ENDEMIC MALARIA.** High densities of *A. quadrimaculatus* are associated with a relatively high degree of endemic malaria in the vicinity of Terre Haute. During the period 1938-40, malaria reappeared in epidemic form after an absence of half a century. The estimated number of cases was 1,500.

**MOSQUITO BREEDING.** The principal "quad" breeding places are situated in the Wabash River bottom within easy



tion. Although levees have been constructed to keep these bottom areas from being inundated by the frequent floods of the Wabash, the underlying porous sand and gravel strata permit easy seepage. Subsequent drainage is delayed by inadequate and faulty drainage structures.

During July of 1938, a river stage of 20.7 feet (6.7 feet above flood stage) occurred. An effort has been made to provide structures which will permit ready drainage of these bottom areas after the floods have subsided.

**LARVICIDING.** Fair control was obtained during 1944 by hand larviciding supplemented by some power spraying and pumping of impounded water. However, it appears that drainage of the bottom areas after floods will be the only effective control measure.

#### FORT HARRISON

**LARVICIDING.** The major breeding place in the Fort Harrison control zone which

is Indian Lake, an impoundment one-half mile north of the reservation. Extensive shallow areas support a dense growth of aquatic vegetation during favorable years. The extent of the horizontal growth determines the method of larviciding. During the 1944 season, hand spraying sufficiently inhibited "quad" breeding. However, the increased growth of horizontal vegetation in the late spring of 1945 necessitated power application of the larvicide.

#### EVANSVILLE

**LARVICIDING.** Numerous ornamental ponds in the parks of this highly industrialized city provide satisfactory environments for "quad" breeding. A joint mosquito control program with the city organization functioned during 1944. Hand spraying achieved good control.

---

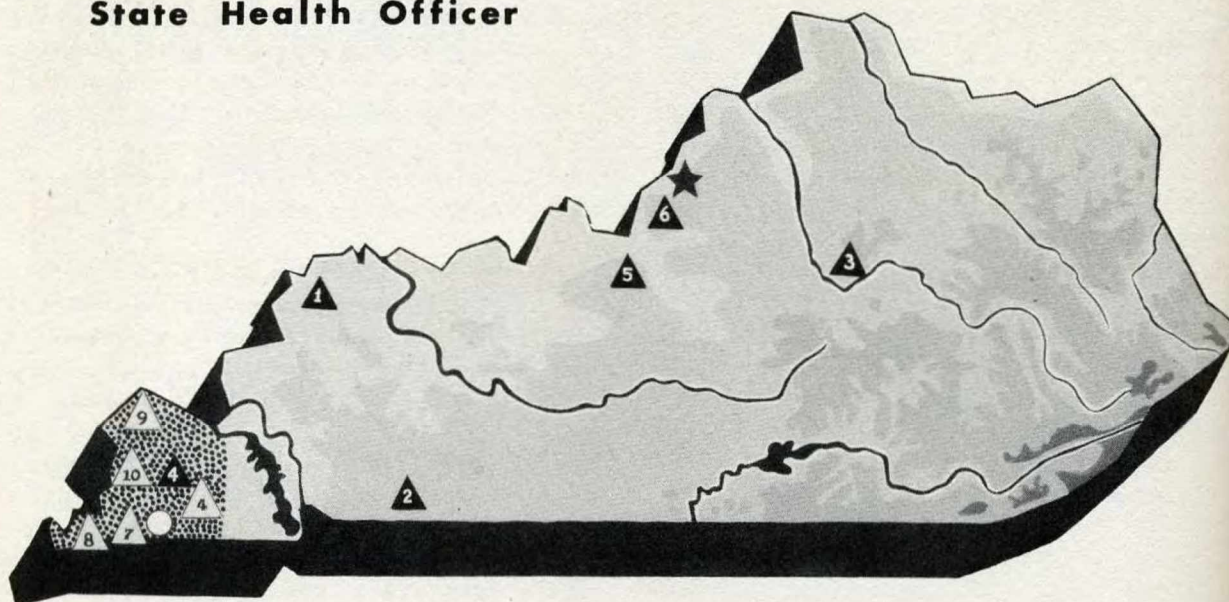
**POWER SPRAYING** at Indian Lake near Fort Harrison.





# KENTUCKY

PHILIP E. BLACKERBY, M. D.  
State Health Officer



## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

## PROJECTS

1. Morganfield-Henderson
2. Hopkinsville
3. East Kentucky
4. Paducah-Mayfield
5. Fort Knox
6. Louisville
7. Fulton
8. Hickman
9. Ballard
10. Carlisle
- ★ Louisville

Malaria control activities in the State of Kentucky were greatly expanded with the inauguration of the Extended Program.

## WINTER ACTIVITIES

Winter activities were confined to making the necessary preparations for Extended Program operations. On the ba-

sis of malaria mortality, the State Department of Health selected six counties in the western part of the State. It was recommended that DDT residual spray be applied to all homes in these counties as a malaria control measure.

Mapping was started in December. County maps were drawn showing the lo-





**ENTOMOLOGICAL SURVEILLANCE.** (Left) Dipping for larvae. (Right) Catching adult mosquitoes in chloroform tube. Two inspectors using spot spraying equipment successfully controlled anopheline production when indicated in the Hopkinsville and Morganfield-Henderson areas.

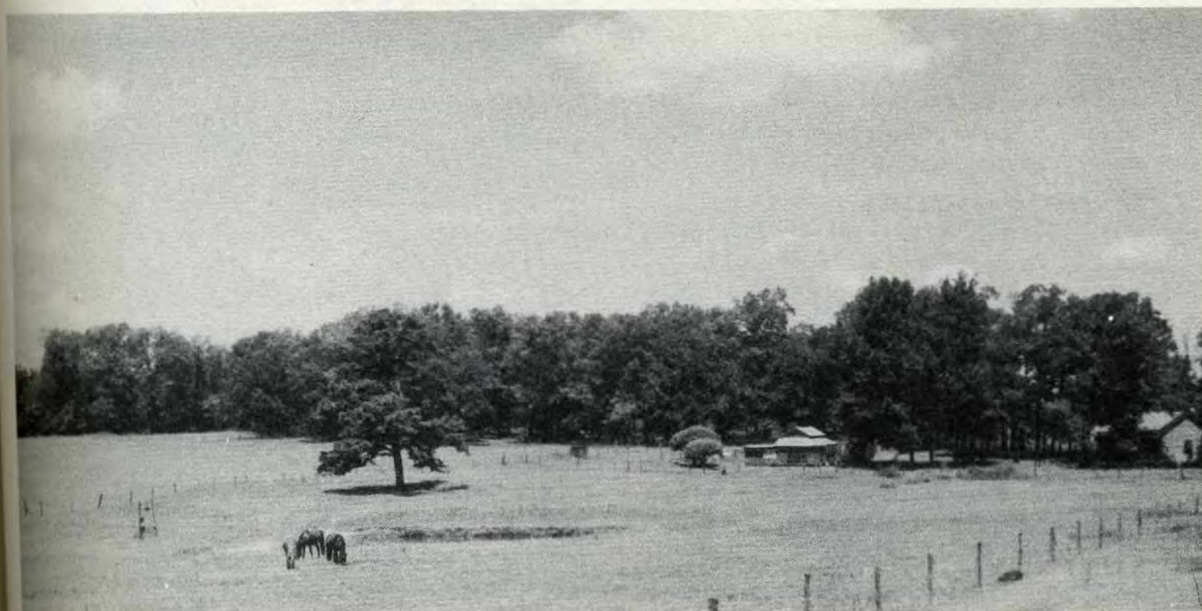
cation of each house. These houses were assigned numbers on the maps and these numbers were later stenciled on the houses.

### SURVEILLANCE AND CONTROL

Nine military establishments continued under surveillance, while 48 war establishments were protected in 6 war areas. No control measures were required in the areas surrounding three of

these establishments in the east central part of the State, and breeding was adequately controlled in the vicinity of the others.

Control activities in the Hopkinsville and Morganfield-Henderson areas were reduced. The areas did not produce *Anopheles quadrimaculatus* in serious numbers during the past season. At present, there are only three inspectors covering these areas. Although the military



**BREEDING AREA.** One of the many stock pond breeding places found in Kentucky. During the past fiscal year approximately 985 acres were larvicided.



personnel at Camps Breckinridge and Campbell have been greatly reduced, control activities may have to be increased during the next fiscal year because the two military camps are being reactivated.

Control work in the Fort Knox area has been expanded to provide protection for military personnel remaining over night on the firing ranges.

Recent flood conditions along the Ohio River have created many more "quad" breeding areas and have greatly enlarged the existing breeding areas in the vicinity of Paducah.

### POW LABOR

By an agreement with the Nichols General Hospital and the Louisville Medical Depot, four prisoners-of-war were furnished to help relieve the labor shortage which was felt during the breeding season in the Louisville area. This was a temporary measure since the prisoners could be used only within one mile of the military installations.

### DDT RESIDUAL SPRAY

Approximately 12,000 homes in western Kentucky were treated with DDT residual spray.

It is estimated that some 18,000 homes in McCracken, Graves, Ballard (Area 4), Hickman (Area 8), Fulton (Area 7), and Carlisle (Area 10) Counties will be sprayed.

Some difficulty has been experienced in securing and training personnel for DDT work. All men assigned to DDT work are thoroughly trained before they are assigned to field operations. The labor turn-over has made it necessary to continue training new men for the DDT crews.

The county health departments have shown fine cooperation in supplying the field personnel with materials, office and garage space, and furnishing funds for incidental cash purchases.

Most of the DDT is being applied with hand spraying equipment. A power sprayer was used by one crew for a limited period, but did not prove economical.

During the year, approximately 77,506 persons were protected as a result of house spraying.

### LARVICIDING

Hand operated oiling and dusting equipment was used to control the breeding on the regular MCWA program. The small size and widespread locations of the breeding places made the use of power equipment impractical. Larviciding was limited to locations where "quad" larvae were found. This practice permitted the program to operate with fewer larviciding crews of high quality and effected a saving in both labor and materials. Some 985 acres were treated during the year.

### TRAINING COURSES

A special course in Malaria Control, attended by approximately 75 teachers, nurses and county sanitary inspectors, was conducted at the Murray State Teachers College in collaboration with the State Department of Health, the Headquarters Office, TVA, and several local county health departments.

Several field trips were conducted through the various counties in the western part of the State where the extended and regular MCWA programs were in operation.

Other subjects studied were tuberculosis, general sanitation, and food and nutrition.

Another educational project of the State Department of Health was conducted at the Louisville MCWA headquarters where some 130 medical and dental students from the University of Louisville were shown the field methods of inspection and control of malaria mosquitoes in the Louisville area. The course included lectures, demonstrations, malaria films and field trips. This activity is a part of an annual program in which the medical and dental students of the University of Louisville are shown the operations and procedures of the entire State Department of Health.



# LOUISIANA

DAVID E. BROWN, M. D.  
State Health Officer

## PROJECTS

- |                 |                 |
|-----------------|-----------------|
| 1. New Orleans  | 6. Baton Rouge  |
| 2. Alexandria   | 7. Monroe       |
| 3. Leesville    | 8. Lafayette    |
| 4. Shreveport   | 9. Natchitoches |
| 5. Lake Charles | ★ New Orleans   |



## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

Louisiana is one of the States entirely within the endemic malaria area along the Gulf Coast. It is therefore interesting to note that there has been little incidence of malaria reported in the State in the vicinity of any of the controlled areas. The cases reported from military establishments were usually due to infection either before the men were transferred from points outside the protected areas, or were recurrent cases from overseas. During the year 97 war establishments

were protected in the 8 war areas of the State.

## DDT SPRAYING

An Extended Program of malaria control was begun in parts of 6 parishes in the northern section of the State in which malaria mortality rate was at an index of 19. The Program was based on the spraying of some 16,000 houses which were sprayed at 3-month intervals or approximately 2 sprayings per breeding season.



In six towns within the specified wards more DDT would have been required than was available. In these instances larvicidal projects were put into operation.

Power equipment was used for the application of DDT emulsion whenever it seemed more advantageous than application by hand sprayers. The advantages of power equipment were a constant pressure for application and a better application rate per house where houses were close together.

The disadvantages of power equipment included: difficulty in checking the amount of application per room or house; rapid deterioration of the application hose due to the xylene; loss of time at the end of each day in washing equipment; the weight of sprayers set high on trucks, making a top-heavy load to carry over rough ground.

As a solution to these difficulties, it was proposed to replace the heavy liquid pumps with light air compressors and tap the 2½-gallon Hudson Climax to compressor spray cans for con-

nection of air hose. This will not only produce constant pressure of application but will also reduce the deterioration of the rubber hose. In this way, only a short section of the hose on the sprayer will be in contact with the xylene. Each member of the crew will carry a sprayer and all sprayers will be connected to the air compressor outside.

### REFUGEE CAMPS SPRAYED

During early April, the levees along the Red River and Ouachita River broke in several places flooding large areas within some of the wards in which DDT spraying had been started.

Numbers of refugee camps were established and it was asked that these camps be sprayed with DDT. In compliance with this request, spray crews used 400 gallons of DDT concentrate in treating 3,500 houses or tents, which were temporary living quarters for some 16,000 refugees.

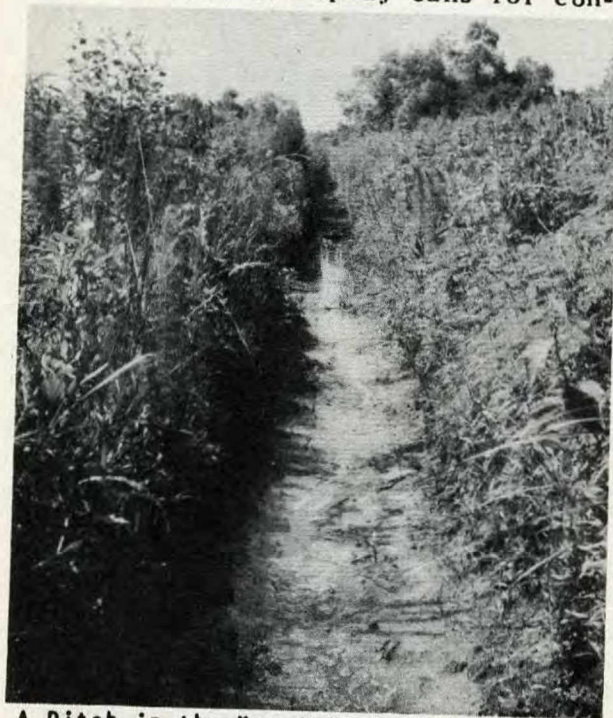
### BACKWATER

The flood backwater was so extensive in Catahoula and Concordia parishes of area seven that a request was made to spray with DDT all the houses in the towns of Jonesville, Harrisonburg, Ferriday and Vidalia. Here the floods had increased the breeding of "quads" and thickly seeded the entire area with adult mosquitoes. One thousand pounds of DDT and the necessary xylene and triton were made available for this purpose and the spraying of the towns was completed early in July.

### JACKSON BARRACKS

The 800-acre swamp lying just north of Jackson Barracks in New Orleans on which a major drainage project was completed in July 1944, was entirely dried up in September by completion of the lateral ditch system. This area had remained dry through the spring wet season and no breeding had been found in the drainage ditches.

However, immediately to the east of this swamp was a heavily wooded area,



A Ditch in the New Orleans area cut with vertical banks due to a heavy root system which holds the soil and makes the banks more stable.



was about 550 acres in size and extended south to the St. Claude highway almost to the Mississippi River. It was drained by St. Bernard parish canals leading to a pumping station where the water was lifted over the levee into Bayou Bienvenue at a point some two miles east of Jackson Levee.

The Parish pumping plant was found adequate to handle the water and maintain a level in the canal system from 1.5 to 0.5 mean gulf level. Pumping would dry up completely the surfaces of the wooded areas provided the equipment was operated regularly, a sufficient number of hours per day.

The Parish was unable to obtain and keep labor pumpers to assure regular pumping. Therefore, MCWA furnished labor for the pumping and the parish supplied operating costs, such as fuel, repairs, etc. With this arrangement, sufficient pumping was done at all times to keep the water below the flood level. The area was dried up and no breeding was found last spring and summer. There

the control zones where the canals were checked with vegetation which is being eliminated by a dragline.

The entire zone was larvicided weekly last season by 30 men using three 1½-ton trucks. At present two men utilizing one jeep with a small power oil pump and drum of oil, can cover the entire zone in less than two days each week. This indicates a saving in labor of 2 foremen and 27 laborers and a saving in equipment of 3 large trucks.

During the last season of 30 weeks when normal larviciding was in operation, a total of 26,657 acres was treated with 541,036 gallons of oil. This can be compared with 42,400 acres treated with 706,500 gallons of oil during the previous season of 24 weeks. There was a 47% reduction in the use of oil in acres treated with 3 additional zones of control over the previous season. This reduction was due to drainage which eliminated breeding areas and to inspection which disclosed those watered areas known to be intermittent breeders.



Part of the drainage system of Jackson Barracks near New Orleans. (Left) Levee constructed by dragline to prevent overflow of stream into adjacent swamp which will be drained into another outfall. (Right) Dragline in action.



# MARYLAND

ROBERT RILEY, M. D.  
State Health Officer

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas

## PROJECTS

- 3. Suburban Washington
- 4. Baltimore  
(Maryland Statewide)
- 5. Southern Maryland
- ★ Baltimore

During the past fiscal year, most of the important malaria breeding places remaining around war establishments were eliminated. An expanded program of entomological surveillance determined the lack of need for control work around a number of war establishments which have never been adequately inspected.

## WINTER PLANNING

Extensive preparations for the next season's work were made during the winter. Maps, both original and revised, station descriptions and map keys, were made of 15 zones. The inspectional force spent most of its time on a watered area census of eight zones under surveillance and on the identification of culicine mosquitoes.

There were three schools conducted on general malariology. The first two were for inspectors immediately concerned with the project. The third was primarily for State Health Department personnel, and included representatives from most county health departments facing a potential malaria problem.

## MOSQUITO COUNTS

Only eight zones produced significant counts of malaria mosquitoes. At Scotland (Area 4) counts were as high as 10,000 per station. There was great variation in time of occurrence of peak populations, ranging from the earliest on June 22 (at Scotland) to September 16 (at Cedar Point, Area 4).

## DITCH CLEANING

During the early part of 1944, a considerable amount of ditch cleaning and spring-fed marsh drainage was done at Camp Springs (Area 5). Most of the "quad" breeding areas were thus eliminated before the beginning of the breeding season.



Heavy mosquito breeding in the vicinity of Bradburn's Pond (Area 4) was eliminated when the Pond was thoroughly cleaned and larvicided. A drought later in the season made further work unnecessary.

Major reduction of breeding surface at Indian Head (Area 5) was accomplished by drainage of a 27-acre marsh along the Potomac River and a large swamp in the triangle bounded by Highways 224 and 225.

The ponds of the V & M Sand and gravel Company (Area 5) were cleaned after the water in the ponds had been lowered. The work was done during the winter when ice coverage facilitated operations.

Prolific aquatic growth on the ponds near Cedar Point (Area 4) caused mosquito breeding which was eliminated by drainage of the ponds during the spring.

### WATER CHESTNUT

At Stump Neck (Area 5), extensive

*quadrimaculatus*. Only fringes of this aquatic plant were left after cutting. Breeding in this limited area was successfully controlled by paris green dusting from boats.

By the end of July, most of the water chestnut plants at Fort Washington (Area 5) which had already been cut, had drifted from Piscataway Creek or had disintegrated and sunk.

With their disappearance, adult counts of "quads" lapsed into insignificance. Small areas of scattered stranded beds of cut plants, which were associated with a limited amount of breeding were dusted with paris green.

In 1945 arrangements were made to obtain 40 prisoners-of-war to assist in removal of water chestnut. These men eradicated the plant from all of the Maryland shores of the Potomac except for one small area. Because of this work, no larviciding will be necessary in Maryland during the 1945 season.



Extensive cutting of water chestnut at Stump Neck and at Fort Washington greatly reduced anopheline breeding.



# MISSISSIPPI

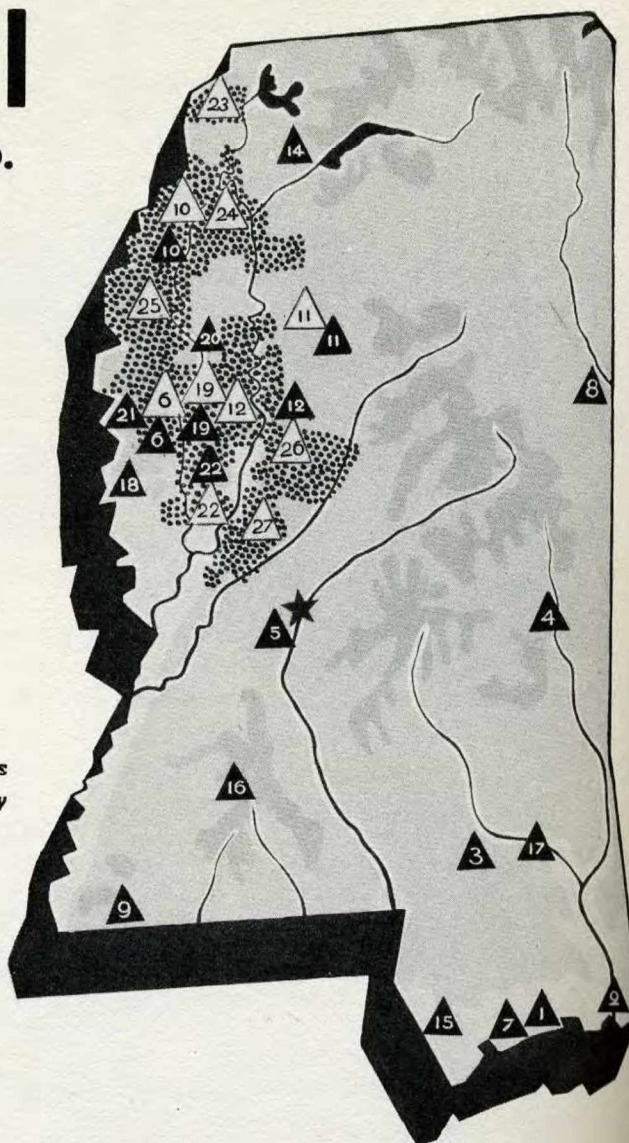
FELIX J. UNDERWOOD, M. D.  
State Health Officer

## PROJECTS

1. Biloxi
2. Pascagoula
3. Hattiesburg
4. Meridian
5. Jackson
6. Greenville
7. Gulfport
8. Columbus
9. Centreville
10. Clarksdale
11. Grenada
12. Greenwood
14. Como
15. Picayune
16. Brookhaven
17. Richton
18. Lake Washington
19. Indianola
20. Drew
21. Leland
22. Belzoni
23. Tunica
24. Quitman
25. Bolivar
26. Holmes
27. Yazoo
- ★ Jackson

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray



Despite some curtailment of military training within the State of Mississippi, the advent of the Extended Malaria Control Program and the establishment of numerous prisoner-of-war branch camps necessitated a considerable expansion of MCWA activities for the fiscal year 1945.

FIELD UNITS REORGANIZED. Because of changing control methods involving house spraying with DDT, field units under

the State Division of Sanitary Engineering were reorganized to conform more closely in general responsibilities and relationships to other local public health programs.

FIELD CREWS. Field crews were made an integral part of the various county health departments, and a concise statement of policies was drawn up to guide directors of county health work and MCWA personnel attached to their organizations.



The statement of general policies pertaining to malaria control work in the counties purports to set up:

- (1) The general responsibilities of and the relationships existing between the agencies involved in the operation of the program within the State.
- (2) The relation of the MCWA program with respect to the over-all public health program of the county health departments.
- (3) The responsibility of the county health department to the malaria control program.
- (4) The relationship of all malaria control personnel, on the county level, with respect to the health department with which they are employed and the director of the department.

### TRAINING CONFERENCE

With the basic organization policy for the Extended Program established, the Mississippi office called a two-day training conference for supervisory personnel, conducted by representatives of the State and MCWA headquarters office.

By utilizing a centrally located county organization for within service training of newly appointed supervisors and inspectors, the program was able to expand field operating personnel as quickly as the flow of needed equipment and supplies warranted.

Last year for the first time, educational activities were carried out by full-time educators. The recruitment of educator personnel was aided considerably by the availability of several educators having former experience in summer malaria educational programs.

Although the primary purpose of the public relations program is to facilitate field operations, it was soon learned that emphasis on DDT alone was not necessary and that householder cooperation could be secured without door-to-door contacts.

were broadened and direction from the State level was placed under the Assistant Director of Health Education with close liaison maintained through the operations division and the local health officer.

With organizational work completed and problems of recruitment and training solved, the outlook is bright for the efficient operation of a well coordinated program of Malaria Control in Mississippi.

There are in this State 21 MCWA areas; 65 war establishments have been protected in the regular MCWA program and in the Extended Program 34,824 houses have been sprayed, and 5,736 acres have been treated. During the past year 316,384 persons have been protected through MCWA activities.



Demonstration of Malaria Control equipment by full-time educators.



# MISSOURI

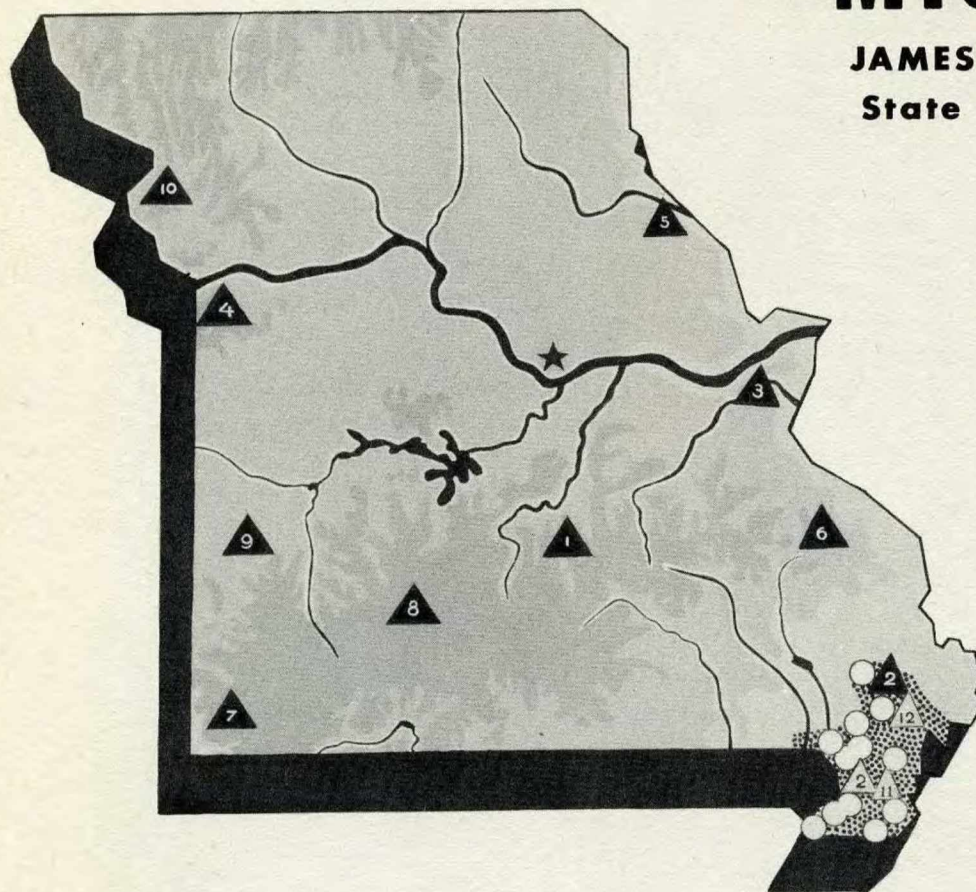
**JAMES STEWART, M.D.**  
State Health Officer

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

## PROJECTS

1. Ft. Leonard Wood
2. Sikeston
3. St. Louis Co.
4. Ft. Leavenworth
5. Louisiana
6. McBride
7. Camp Crowder
8. Springfield
9. Nevada
10. St. Joseph
11. Pemiscot
12. New Madrid
- ★ Jefferson City



Entomological inspections during the years 1942-43-44 indicated that *Anopheles quadrimaculatus* occurs in varying numbers in all parts of Missouri from the sparse populations of the Ozark hills to the heavy densities in the river bottoms of the Missouri and Mississippi Rivers.

During the past fiscal year, operations were discontinued around the McBride Air Base at McBride; Cape Girardeau School of Aeronautics in the Sikeston area; and the Katz Air College in the St. Louis area. These flying

fields were closed because of general curtailment of primary contract school flying. The Sikeston School of Aeronautics at Sikeston was closed October 15 and it is anticipated that it will not be reopened in 1945.

Control areas which were added during 1944 were the Smart Field Naval Flying School in the St. Louis area; the city of Neosho near Camp Crowder; the Chesterfield POW camp in the St. Louis area and Rosecrans Ferrying Command flying field at St. Joseph.

The Veterans Administration Hos-



area), which will provide 2,800 beds for World War II patients, will be included in the coming year's program.

Last year through MCWA activities, 45 war establishments were protected in the 10 war areas of the State.

## DRAINAGE

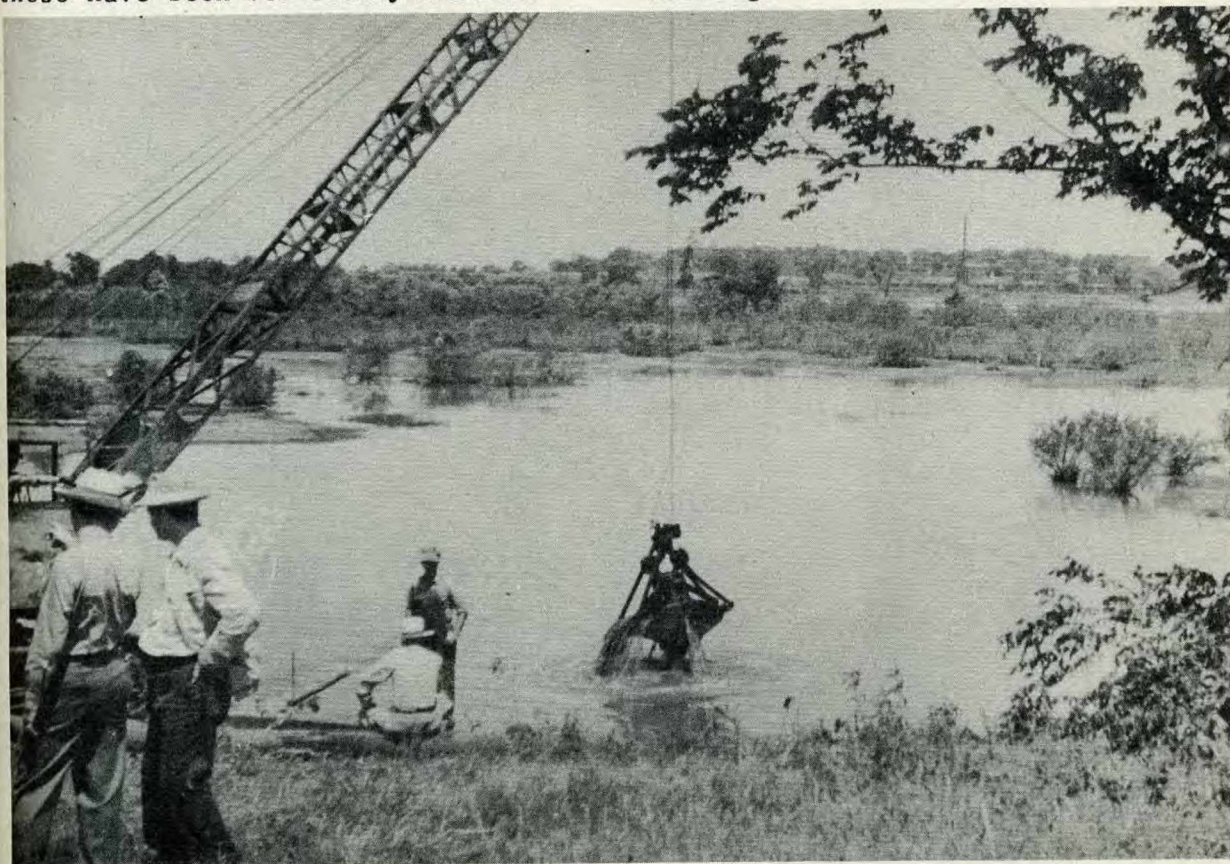
Vertical drainage of the "Frisco Ponds" eliminated the only serious "quad" breeding in the Springfield area. In the future, larviciding will be confined to spot work wherever "quads" are found.

The LeMay Sink Hole (St. Louis area) was vertically drained in the winter of 1943 and is still functioning. The terrain around Jefferson Barracks is very rolling and underlaid with limestone. There are 92 limestone sinkholes which breed mosquitoes during the year. Many of these have been vertically drained.

Approximately 10,318 acres were larvicided during the year throughout the State.

A feature of the Camp Crowder area was larviciding of the State Fish Hatchery of the city of Neosho where heavy "quad" breeding was occurring. A pronounced decline was noted in the town's "A" stations when these ponds were larvicided weekly during the summer.

Power dusting from outboard motor boats was done in the Louisiana area. The results indicated that more of this type of work should be inaugurated in other areas. Boats were equipped with a 100-pound hopper capacity power duster and a 5 h.p. outboard motor, which made a successful operating unit for navigating the river and spreading dust. A ratio of six parts of lime to one part of paris green was used for dusting.



"Frisco" Ponds in Springfield Area. The drainage of this 30-acre sink eliminated the only serious breeding spot in this area.



## DDT EXPERIMENT

In the Extended Program 19,961 houses were sprayed with DDT during the year.

A DDT experiment was conducted around Duck Lake (Ft. Leavenworth area) where heavy "quad" breeding occurred. A solution was prepared using 5 gallons of xylene, 13 pounds of triton, 210 ounces of DDT and sufficient water to make a 30-gallon solution. This 5% solution was used to spray all natural resting places on the Missouri side of the river, thus laying down an insect barrier between the breeding places and the Fort. The mixture was applied with an Indian Head trombone-type hand sprayer.

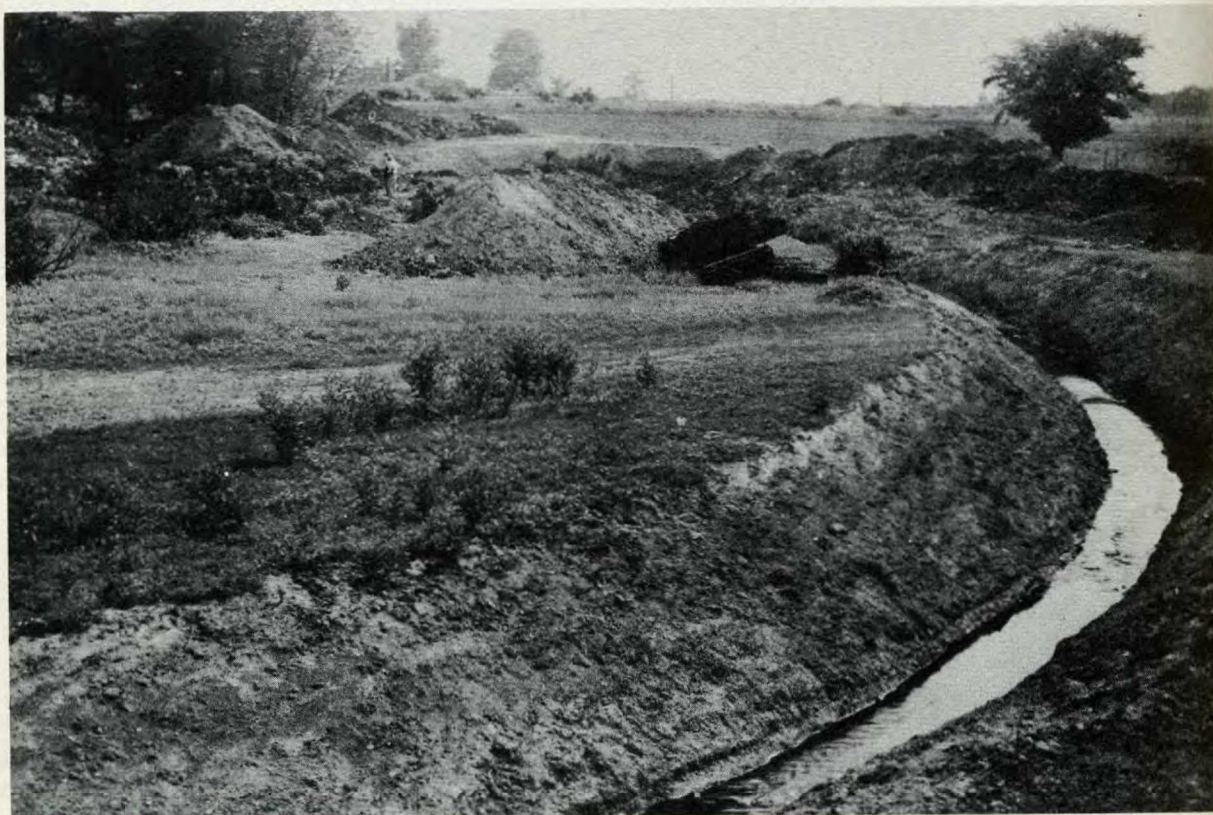
Field reports showed that the experiment was successful because of almost total absence of mosquitoes from the resting places for several weeks after the conclusion of the experiment. It is intended to repeat this early next year so that results over a longer period of time may be studied.

## ENTOMOLOGICAL SURVEY

An entomological survey was made of Big Piney Bivouac area adjacent to Fort Leonard Wood, where a case of malaria is a rarity due to the rolling and well drained country. No control was considered necessary because the highest count of "quads" in an adult station was six.

A POW side camp has been located at Rosati and will house about 120 prisoners. This camp will be inspected during the coming year by personnel from the State Office at Jefferson City.

Plans also include an occasional survey of the Weingarten POW camp located in a hilly, stony, well drained area with only a few stock ponds and barrow pits for mosquito breeding. There are about 2,000 prisoners at the camp and 600 army soldiers and civilians stationed there. Among the Italian prisoners several cases of malaria are under treatment at all times.



VERTICAL DRAINAGE. Ditch to a natural lime sink that has been opened up and is used for vertical drainage.

Courtesy of the David J. Sencer CDC Museum



## WATERED AREA CENSUS

The watered census of the Sikeston area showed 101½ acres of ponds and streams over 10 feet in width and 105,960 lineal feet of ditch under 10 feet in width under control or surveillance in 1944. A total of 28½ square miles of area were under control or surveillance in this area.

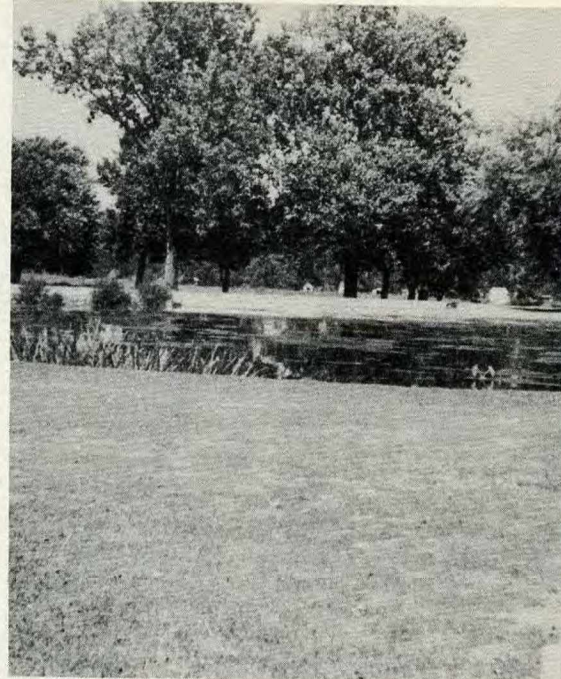
In the St. Louis County area, the watered surface under surveillance or control is as follows: 2,021 acres of ponds and streams over 10 feet in width and 248,120 lineal feet of small streams and ditches. The area under surveillance or control totals 27 square miles.

The protected section in the Fort Leavenworth area is 3 square miles and the total area controlled and protected is 18.5 square miles. The watered area is 319 acres of ponds and streams over 10 feet in width and 65,800 lineal feet of ditch under 10 feet in width.

The watered territory of the Louisiana area includes 2,802 acres of ponds and streams over 10 feet in width and 33,600 lineal feet of ditch under 10 feet in width. In this area, there is a small shanty settlement along the Mississippi River which seems to be a focus for endemic malaria according to blood smears taken during the Upper Mississippi River Surveys in 1941 and 1942. The employees of the Missouri Ordnance Plant, the military establishment protected, number between 500 and 650. The Town of Louisiana has a population of 5,000. 120 German prisoners are housed in the old NYA barracks and work in the Stark Nurseries.

There are 700 acres in the McBride area and the watered area is 0.45 acres of ponds and 50,160 lineal feet of small streams.

In the Camp Crowder area, there are 34 acres of ponds and streams over 10 feet in width and 32,600 feet of small ditches and streams. The total area under control and surveillance is 11.7 square miles.



Neosho Fish Hatchery, which is larvicided weekly.

The protected zone in the Springfield area comprises much of the populated section of the city of Springfield, and includes 3¼ square miles. The watered area after major drainage is about 3 acres of ponds and 16,500 lineal feet of small ditches.

## EXTENDED PROGRAM

Dunklin County (Area 2), where the Malden Air Base is located, is one of the 68 counties selected by MCWA headquarters for extended malaria control. The Malden Air Base has about 4,000 military personnel and 1,000 civilian employees. The terrain around the Base is very flat and drained by an extensive system of agricultural drainage ditches. Water vegetation abounds in these ditches and "quads" are found in large numbers, both in the larval and adult stages. The inclusion of New Madrid (Area 12), Dunklin (Area 2), and Pemiscot (Area 11) counties in the War Areas Extended Program will result in a substantial expansion of the present MCWA program.





# NORTH CAROLINA

**CARL V. REYNOLDS, M. D.**  
**State Health Officer**

## PROJECTS

- |                   |                |
|-------------------|----------------|
| 1. Ft. Bragg      | 9. Maxton      |
| 2. Wilmington     | 10. Hoffman    |
| 3. Jacksonville   | 11. Rockingham |
| 4. New Bern       | 12. Charlotte  |
| 5. Elizabeth City | 13. Edenton    |
| 6. Camp Butner    | 14. Asheville  |
| 7. Monroe         | 15. Greenville |
| 8. Goldsboro      | 16. Raleigh    |

## LEGEND

★ State Hdqrs.

▲ War Areas

▨ Residual Spray

★ State-wide Extended Hq.

The basic changes in malaria control operations which have occurred in the State of North Carolina during the past fiscal year are: a drastic reduction in major drainage; an increase in the amount of maintenance work performed; and the addition to the program of the DDT residual spray operations.

During the past year, 88 war establishments in 15 war areas were protected.

## MAJOR DRAINAGE

One major drainage project was undertaken in the Wilmington area in cooperation with the city and county authorities. MCWA assisted by furnishing the necessary hand labor. This project eliminated an outlet ditch at the city limits which for years had presented a control problem because of its inaccessibility to larviciding.

Another major drainage project was recently started in an area adjacent to Moore General Hospital near Asheville to eliminate abandoned gravel pits. Although this area is in the mountains and not near what may be considered a malarious section, it has special significance in that Moore General Hospital is caring for thousands of malaria and other tropical disease cases, and that considerable "quad" breeding has been found at the area to be drained. Although larviciding could be employed, it is felt that permanent drainage is preferable in view of the permanence of the hospital installations.

A total of 279 acres of watered surface was eliminated by drainage during the past year. This involved the movement of 26,278 cu. yards of earth from 588,347 linear feet of new ditches.



ENVIRONMENTAL  
One hundred and thirty four acre applications of paris green were made during the year and 1,527 acre applications of oil were made. Power equipment was used for application wherever field conditions permitted. This was particularly true in the Elizabeth City area.

With few exceptions, it has been practical to discontinue larviciding by proper maintenance of drainage systems in a number of small areas. Larviciding has also been discontinued in several areas where it was formerly necessary to do extensive control. By combining many areas which have been drastically reduced in size of operation, it has been possible to reduce the overhead supervision as well as the number of persons employed to do the job. Greater use of inspection has made it feasible to discontinue areas small portions of areas which do

not produce significant numbers of malaria mosquitoes.

### MAINTENANCE OF DRAINAGE SYSTEMS

Maintenance of existing drainage systems was used whenever possible to reduce the watered areas and hence the need for larviciding.

A number of MCWA activities are located in regions where considerable construction is either under way or has been completed recently. An extensive erosion problem was created in these areas by the removal or disturbance of earth. As a result, many new drainage ditches and old canals, filled by debris from erosion, necessitated much work in maintenance.

On numerous occasions dynamite was used advantageously to blow silt from the ditches, particularly in the larger swamp ditches. There were 10,000 acres of ditches cleaned and 2,251 acres cleared during the year.



Dynamite was used advantageously for ditching near Ft. Bragg.



## DDT RESIDUAL SPRAY OPERATIONS

The program of home spraying of malaria cases is planned as an effective and important stride in the direction of preventing a recurrence of a large scale malaria epidemic in North Carolina.

The original state-wide project has been revised to include DDT spraying of all homes of current malaria cases, irrespective of location. The malaria cases, however, must be substantiated by a positive blood slide by the State laboratory or other responsible source.

The local health officers have contacted the medical practitioners and have requested that they report immediately all cases of malaria to the local health department.

Army authorities have also been contacted in order to obtain information as to the home locations of discharged soldiers having a malaria history.

When a case of malaria is reported, a thick film blood slide is obtained before treatment is started. This slide is sent to the Division of Epidemiology, State Board of Health, Raleigh, together with a report card showing complete address of the patient.

In cases of servicemen, a blood smear is requested when the disease is active. When inactive, a statement signed by the health officer that the patient has had a malaria history, suffices.

If the smear is found to be positive in the State malaria laboratory or if the service record is positive, arrangements are made to have the residence of the patient sprayed with DDT.

Since only a limited amount of DDT is available, spraying is confined to homes where malaria has been demonstrated by smear or where a serviceman's record shows a history of this disease.



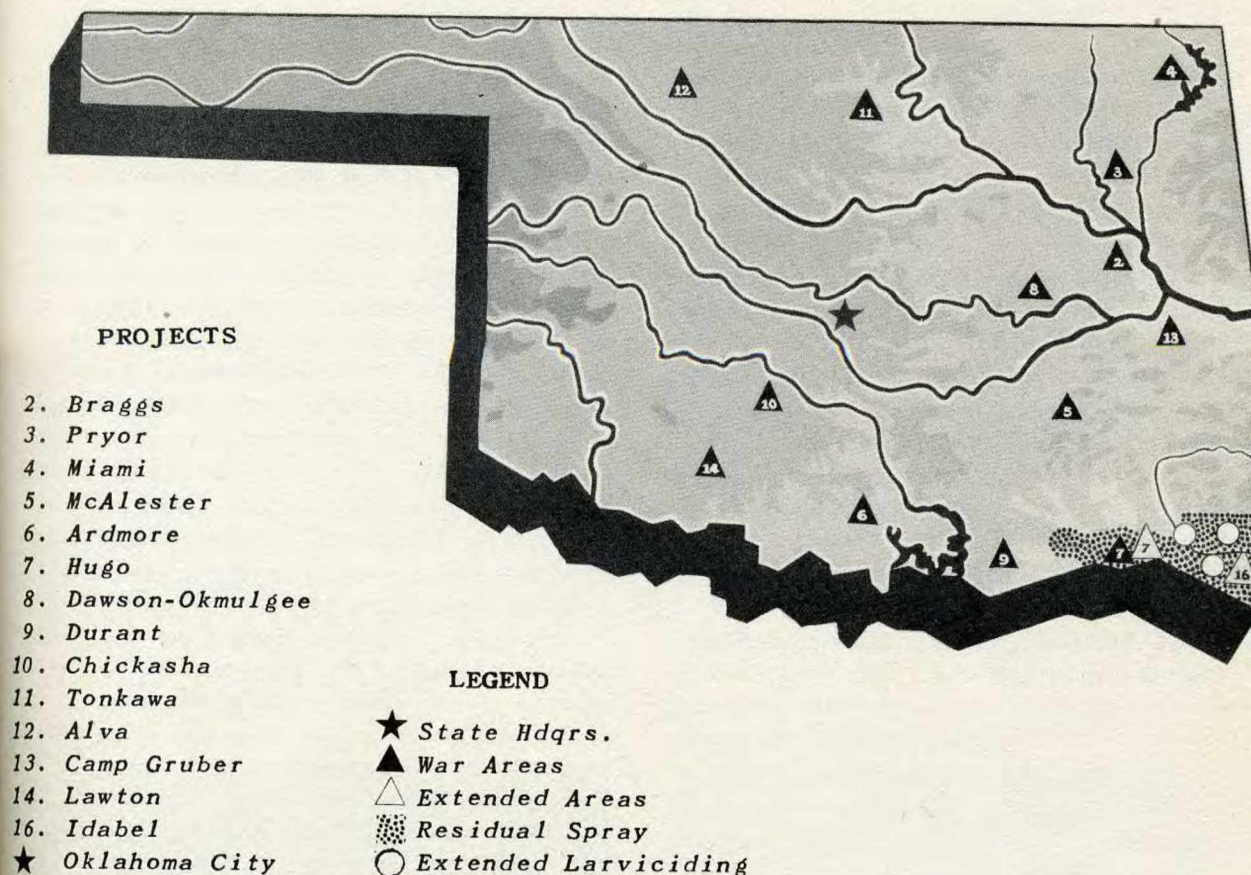
DRAGLINE CANAL. Two hundred and seventy-nine acres of watered surface were eliminated by drainage during the past year.



# OKLAHOMA

## GRADY F. MATHEWS, M.D.

### State Health Officer



The MCWA program in Oklahoma during the past fiscal year was a continuation of control methods already in operation with emphasis on improvement of technics and development of an improved method of entomological inspection.

One of the most expeditious procedures employed was a "sectional method" of sampling larval mosquito breeding places. This system uses land-sections and quarter-sections, instead of arbitrarily selected stations, in listing, locating and reporting collection sites. Numbering of individual breeding places is unnecessary on the area map, and inspections can be accurately reported by any qualified inspector on

first acquaintance with the area. The collection data are given permanent significance by direct relation to the land-section numbers, and are subject to interpretation by anyone who can read an ordinary county map. This method was used experimentally during the previous year and proved successful. It is applicable, however, only when section lines are well defined.

The first requisite is an accurate field map showing land-sections and all watered areas. In zones under routine inspection and control, the inspector also carries a field list of all possible breeding places in each quarter-section. Control operations precede the inspection and are also



organized on the sectional system. The circuit of inspection covers every type of productive water body in at least one quarter of each section through each week, with complete coverage of every section thus accomplished monthly.

Collection results are entered on the field record and transcribed on the summary sheet according to standard procedure with two exceptions. The section number plus the quarter-section designation (NW, NE, SW, SE) becomes the station number, followed by the conventional indication of station distance (-A, -B, -C, -D). And, the specific type of water body is always stated for each collection site (i.e., 1NW-B, Stock pond; 2SE-A, Intermittent stream, etc.). On the weekly entomological report (Form M-7), the number of larval stations equals the number of land-sections wholly or partially included by the control limits. Quarter-section collections thus have the general nature of substations.

**COST REPORTS.** The usual procedure of submitting progress reports for each area is followed and broken down to zone reports. These reports are pre-

pared in the fall and furnish information to the State Department of Health on amounts of oil, paris green, ditching, clearing, cleaning, man-hours, etc., used. The reports will also be valuable in setting up malaria control projects for towns and cities in the future.

## CONTROL OPERATIONS

**WINTER ACTIVITIES.** During the winter, a watered area census was made and zones were remapped. Inspections were made during the winter to determine hibernating habits. Stations were selected at random. This was primarily to locate stations for the next season.

**STATE MEETINGS.** The area supervisors and inspectors met in Okmulgee, April 23-24, and in Hugo, April 26-27, to review the basic responsibilities of inspection procedure and to initiate the seasonal program. The Hugo meeting was also attended by inspectors attached to the Lake Texoma mosquito survey, inaugurated in May with headquarters in the Denison sub-office of the U. S. Engineer Department. On March 1-2 a meeting was held at Hugo



OKLAHOMA CONTROL AREAS. (Left) Back water area on Neosho (Grand) River near Ft. Gibson. (Right) Swamp along Arkansas River at Gore.



with the personnel who were to work on the Extended Program. On April 12 an educational meeting was held in Oklahoma City.

**INSPECTIONS.** Routine inspections began in May in all regular MCWA zones. There was low production in these zones with evident seasonal delay, cool weather and heavy rains persisting through the spring.

**LIGHT TRAPS.** Seven light traps were strategically placed to determine the types of mosquitoes and their abundance.

**LARVICIDING.** With the peak of the season during July, considerable larviciding was done from July to September of 1944. This work was terminated in October but resumed in April of 1945.

**DRAINAGE.** Labor crews were kept intact for clearing, cleaning and drainage work in McAlester, Pryor, Miami, Okmulgee and Dawson during January, February and March.

### EXTENDED PROGRAM

The Extended Program started in April and consisted of interior spraying of rural houses with DDT. The southern halves of McCurtain (Area 16) and Choctaw (Area 7) Counties were sprayed because previous blood surveys had indicated malaria prevalence. As of June 30, some 5,039 houses had been treated with 1,269 pounds of DDT. This work required 5,818 man-hours of labor or 1.15 man-hours per house.

In the Extended Program counties, high mosquito production was already under way by the last two weeks of June. Single station collections of adult *Anopheles quadrimaculatus* were sometimes in excess of 100.

Monthly inspections provided information as to the local seasonal occurrence of malaria mosquitoes and the numbers remaining in sprayed houses after various time intervals. From this information, the effectiveness of the spray and the adequacy of field technique could be determined.

The first inspection was completed during the latter part of June. This included random selections of about 2% of the houses sprayed in each county. Inspections were made of at least one unsprayed natural resting place in each house location to check the seasonal production of malaria mosquitoes.

**PUBLIC RELATIONS.** A public relations section was organized to inform householders of the objectives of the Program and the preparation of dwellings for application of DDT. This section also outlined an educational program on fundamental knowledge of malaria, its transmission and control.

The public relations work and inspection in connection with the Extended Program were handled by one malaria control assistant, who alternated his duties in the two counties with assistance from the State MCWA office. At present an educator is preparing a malaria workbook for use in schools.

**EQUIPMENT.** More equipment was needed for the Extended Program than was on hand, so 19 weapon carriers, 2 ambulances, 1 sedan and three 1½-ton trucks were obtained.

It was evident that automotive repair bills would be excessive during the coming year because of the age and condition of equipment. Consequently a building was rented at Hugo as a garage and warehouse, and one mechanic, one mechanic's helper and a clerk were hired.

The program of special reconnaissance surveys and occasional inspection in areas of POW branch camps and Army and Navy hospitals was continued. An entomologist from the Oklahoma Department of Animal Biology, University of Oklahoma, was assigned to these surveys with direction and assistance by the State MCWA entomologist. This representative of the State Department of Health and member of the University staff, will thus become familiar with the work that MCWA is doing and will be able to contribute to malaria control activities when these are discontinued by MCWA.



# OREGON

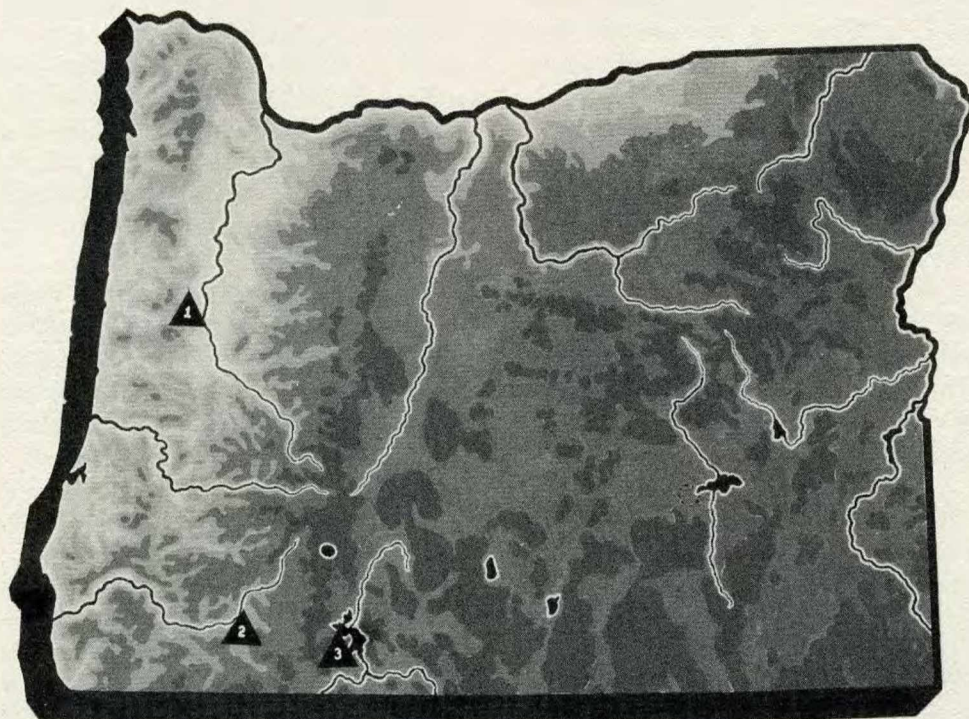
## LEGEND

▲ War Areas

## PROJECTS

1. Corvallis
  2. Medford
  3. Klamath Falls
- ★ Hd. in Calif.

H. M. ERICKSON, M.D.  
State Health Officer



Sporadic outbreaks of malaria have occurred in various sections of the Willamette River Valley during the past few years, but generally control work is confined to areas around Camp White near Medford and Camp Adair at Corvallis in the heart of the Willamette valley.

### LARVICIDING AND MINOR DRAINAGE

A larviciding and minor drainage project was initiated in the vicinity of Camp White, when periodic inspection disclosed significant breeding of *Anopheles freeborni* within a mile of

the prisoner-of-war stockade. Close cooperation was received from the Army authorities at Camp White who furnished a POW crew. Thus, the hazard of malaria transmission from infected prisoners was satisfactorily reduced, as evidenced by the resultant absence of local transmission. Some 57 acres were treated in the 3 war areas protecting 11 war establishments.

### MOSQUITO SPECIES

The anopheline fauna in the Camp White area differs from that found in



dominant species, *A. freeborni* greatly exceeds it, making up 95% of the adult anopheline population, while *A. punctipennis* constitutes 1.5% and *A. pseudo-punctipennis franciscanus*, 3.5%. Secondly, the *franciscanus* adults taken here were the first confirmed specimens of this species in the State. Previously *A. franciscanus* had not been confirmed north of northern California on the west coast.

### INSPECTIONS

Control measures were discontinued at Camp Adair and surrounding towns when the Army disbanded the Camp. Subsequently, the Navy reopened the Camp Adair Hospital, and periodic inspec-

thereof. Periodic inspections were also made at the U. S. Marine Barracks, Klamath Falls where 3,000 Marine Corps personnel are convalescing from malaria and filariasis. No extra-cantonment control was found necessary.

Reconnaissance surveys of various areas have shown the presence of some malaria vectors but no history of malaria. In Josephine County in the southern part of the State, there was a recent report of two proven cases of malaria contracted from a returned soldier having malaria. This incident proved that the entrance of a suitable human carrier into an area previously free of malaria, may supply the conditions necessary for transmission.



ANOPHELINE BREEDING  
AREAS IN OREGON.  
(Above) Near Camp  
White. (Right) Near  
Santiam-Willamette  
River junction.



# SOUTH CAROLINA

**BEN F. WYMAN, M. D.**  
State Health Officer

## PROJECTS

- |                  |                                      |
|------------------|--------------------------------------|
| 1. Beaufort      | 17. Walterboro                       |
| 2. Bennettsville | 18. Georgetown                       |
| 3. Camden        | 19. Pageland                         |
| 4. Charleston    | 20. Summerville                      |
| 5. Columbia      | 21. Congaree                         |
| 6. Florence      | 22. Greenwood                        |
| 7. Ft. Moultrie  | 23. Moncks Corner<br>(Santee-Cooper) |
| 8. Greenville    | 24. Harleyville                      |
| 9. Lexington     | 25. Hampton                          |
| 10. Myrtle Beach | 26. Barnwell                         |
| 11. Aiken        | 27. Clarendon                        |
| 12. Orangeburg   | 28. Kingstree                        |
| 13. Spartanburg  | 29. St. Mathew                       |
| 14. Sumter       | 30. Ridgeland                        |
| 15. Hiltonhead   |                                      |

★ Columbia

In this State, all MCWA employees working in a county were assigned to the respective county health department and operated as a part of that health department. The increased experience of the field personnel made the operation of the program more efficient than in preceding years.



## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

Approximately 122 war establishments were protected in 24 war areas. As a result of MCWA activities 155,213 persons were protected.

The air bases at Camden and Bennettsville were terminated during the year. The Georgetown area, discontinued since 1943, was reopened when the Marine Air Corps established an air base there.

Four new prisoner-of-war branch camps were established in Berkeley (Area 23), Greenwood (Area 22) and Newberry (Area 14) Counties where it was necessary to do some mosquito control.

The county health officers and area supervisors had frequent conferences with the camp commanders and effected satisfactory solutions to mutual problems.

## DRAINAGE

The drainage accomplished in previous years reduced the control work



ing areas had been eliminated.

Ten major drainage projects were completed in the State at a cost of \$40,703 in seven areas. All major drainage projects were constructed by hand except one large project in the Fort Jackson area which was done under contract.

Some minor drainage was undertaken during the year in all areas. Special emphasis was placed on maintenance of previously constructed drainage projects. This resulted in 22,670 square feet of ditch cleaning and the expending of 123,396 man-hours.

A small bulldozer was used in the Charleston area to eliminate a number of small ponded areas. All drainage and filling projects eliminated known "quad" breeding areas. Some 81,162 yards of filling were accomplished to eliminate 170 acres of breeding water surface.

### LARVICIDING

"Quad" control was simplified in the fall months by unusually dry weather throughout the State. However, it was necessary to keep all areas under surveillance and to larvicide most of the water that remained during the dry weather.

Due to warm weather during February and March, breeding occurred approximately one month earlier than previously recorded. In several areas, "quad" adults reached a relatively high density before they were brought under control.

With few exceptions the stations in the "A" and "B" zones have shown very low "quad" densities. To achieve this control 74,874 gallons of oil larvicide were sprayed on 4,899 acres of "quad" breeding water surfaces. This work required 37,623 man-hours of labor. Paris green dust was used in limited areas not readily accessible to oilers; 1,922 pounds of dust were applied to 1,704 acres of breeding area.

has not been inaugurated because of lack of equipment. It is planned to start this work as soon as equipment and labor are available.

An intensive medical, entomological, and engineering study of the malaria problem was made during the year in the vicinity of Clarendon (Area 27), Berkeley (Area 23), Orangeburg (Area 13), Calhoun (Area 29), and Sumter (Area 15) Counties. This work supplemented the data previously obtained by the State Board of Health. Likewise it corroborated previous findings of the State Board that malaria was quite prevalent in this area and that "quads" were breeding in large numbers. Much additional detailed information regarding housing, drainage, and mosquito control problems was collected by the study.

### DDT SPRAYING

Residual house spraying was begun in 11 counties in April and early May. Previous malaria investigations including county-wide thick film blood surveys and subsequent mapping, enabled MCWA to select the known malarious areas in these counties for spraying.

The program was organized into spray crews of 3 men each including the foreman.

One entomologist was made responsible for the inspection work to determine the effectiveness of the spray. Assisting him were 5 inspectors making the routine field inspections in the counties.

A total of 19,412 houses were sprayed from April 15 through June 30, using 9,288 pounds of DDT and requiring 33,597 man-hours of labor. There were occasional refusals to having houses sprayed but as a whole the response to the program was enthusiastic and cooperation excellent. The houses sprayed were principally 5-room and 6-room homes of farm tenants and landlords.

Greater efficiency in spraying has been noted with the increased experience of the





**ABOVE.** Batter boards set to finish grade to proper elevation.  
**RIGHT.** Parasitemia survey in the vicinity of the Santee-Cooper Reservoir.



labor. Probably this will be reflected further in the following months.

A demonstration study of the effectiveness of DDT residual house spraying on malaria prevalence was begun in Clarendon and Berkeley Counties in areas where a significant malaria prevalence has been shown on previous surveys. Other cooperative research studies on the prevalence and epidemiology of malaria were begun during the year.

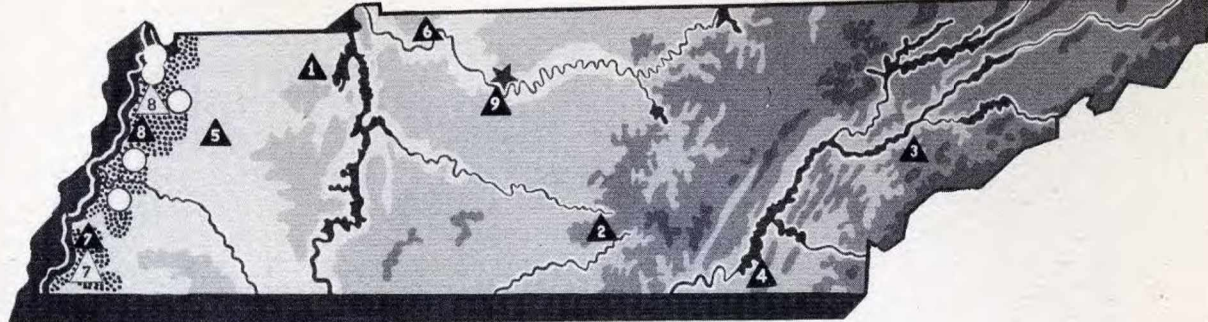
### **AEDES AEGYPTI**

One *Aedes aegypti* control program was successfully operated in Charles-

ton and vicinity. This program has been in operation in Charleston continuously since 1937. The *aegypti* premise index reached slightly higher levels this year than last year. The highest index of 8.83 for the year occurred during September 1-15, 1944. A few abandoned cisterns were found during the year.

Breeding was also found in the City catch basins. Surveys were made at Beaufort where an index of 18 was found in March. At Florence an index of 3.5 was found in early July. Integration of the *aegypti* program in Charleston with the general sanitation program was effected during the year.





# TENNESSEE

**R. H. HUTCHESON, M. D.**  
**State Health Officer**

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding

## PROJECTS

1. Camp Tyson
2. Camp Forrest
3. Alcoa
4. Volunteer Ordnance Plant
5. Wolf Creek Ordnance Plant
6. Camp Campbell
7. Shelby
8. Halls Air Base
9. Smyrna
- ★ Nashville-Smyrna

The MCWA program in Tennessee has continued to function as a service in the Preventable Disease Division. Major drainage, minor drainage, and larviciding for control of malaria mosquito breeding were employed in the vicinity of Army and Navy posts, essential War industries, and housing areas where there was a potential malaria problem.

## LARVICIDING

As indicated by adult counts in "A" stations, *Anopheles quadrimaculatus* in general was satisfactorily controlled during 1944. However, during May and June heavy rainfall resulted in extensive flooded conditions in certain zones in west Tennessee where larvicidal projects were in operation. The extensive flooded condition could not be controlled and vast broods of

"quads" emerged. "Quad" counts in these zones were among the highest on record. Counts in "E" stations as well as "A" stations were much higher than they had been in those zones which have been in operation for several years.

## EXTENDED PROGRAM

Congress appropriated funds in January 1945 for an Extended Malaria Control in War Areas Program. This was to be an emergency measure to prevent the spread of malaria as a result of returning malaria carriers being released by the armed forces. This program was restricted to the most malarious areas in the State as determined by mortality statistics. The program provided for the spraying of all rural homes in the selected areas with an emulsion containing DDT.



### DDT SPRAYING

Approximately 12,000 houses in the most malarious areas of Dyer, Lake, Lauderdale, Obion, Tipton (All Area 8) and Shelby (Area 7) Counties were sprayed during April, May, and June of 1945.

Plans are being made to extend this program into one or two other counties in west Tennessee which have problems almost as great as those in which the program has been operated.

In the Fisher Aircraft zone which is located near the mouth of the Wolf River in Memphis, late spring floods each year result in the establishment of large inaccessible areas of "quad" breeding. As a result "quad" counts are heavy for many weeks each summer. Accordingly, this zone was treated in 1945 with residual spray.

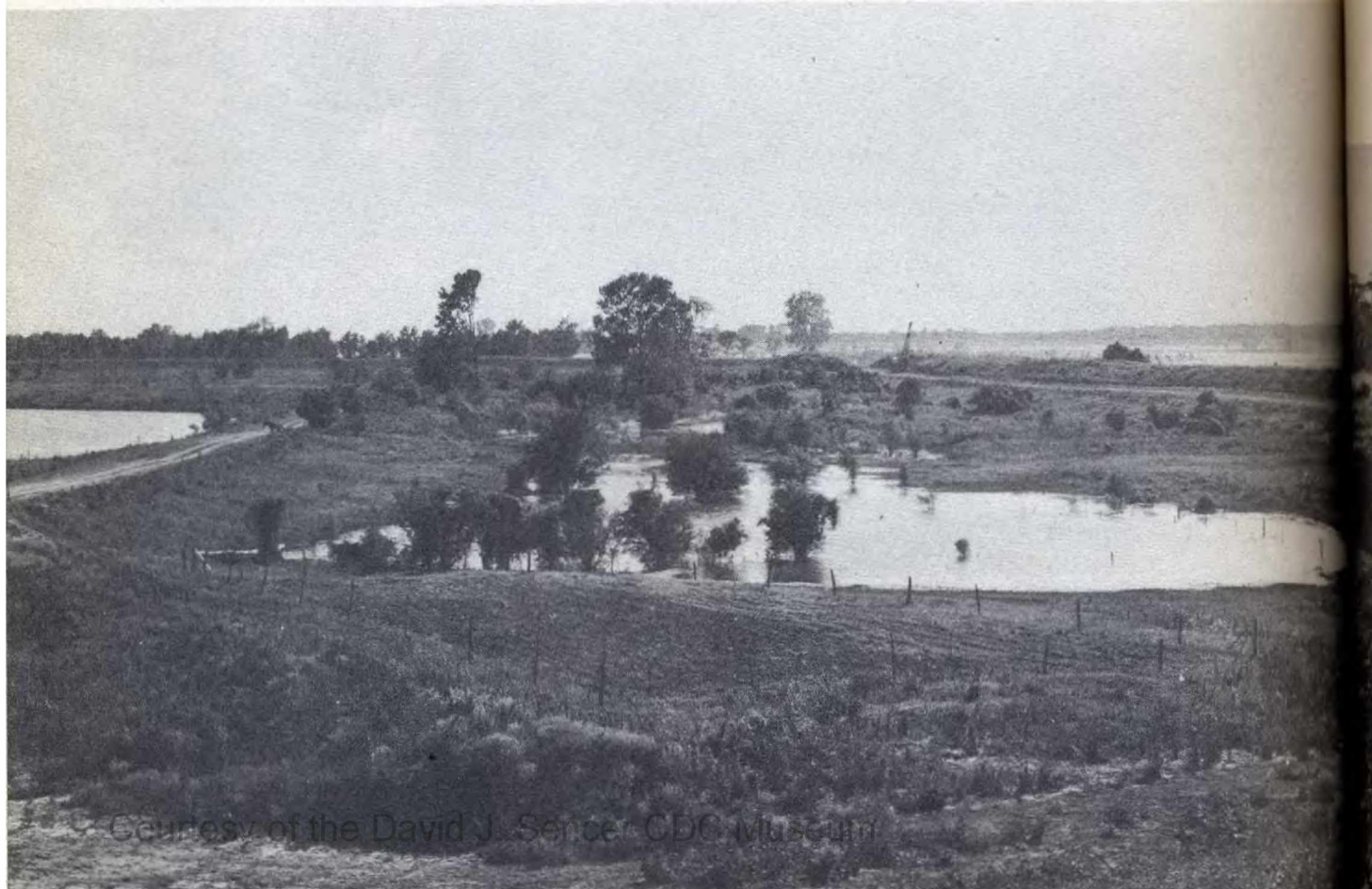
**ANOPHELINE BREEDING PLACES** created in impounding water. In 1945 the General Assembly enacted a law pertaining to impoundage of water. This law holds great promise in controlling malaria and other mosquito-borne diseases.

### CONTROL OF IMPOUNDED WATERS

The first impounded water regulations were adopted by the State Department in 1935 under the basic public health laws and the 1945 General Assembly enacted a law pertaining to the construction and impoundage of water. This legislation holds great promise in controlling malaria and other mosquito-borne diseases which may result from artificial impoundages. Also, the enforcement of the law and the regulations promulgated under the law will benefit vacationers and sportsmen on State-owned and privately-owned lakes by reducing pest mosquitoes.

### EDUCATIONAL PROGRAM

During the summer months, malaria health educators were employed to work in some of the west Tennessee counties





it is a potential problem. These persons held group meetings where talks were made, demonstrations given, and sound pictures presented. In addition, the educators worked in schools assisting teachers in instructing children concerning the cause and prevention of malaria.

#### ENTOMOLOGICAL DATA

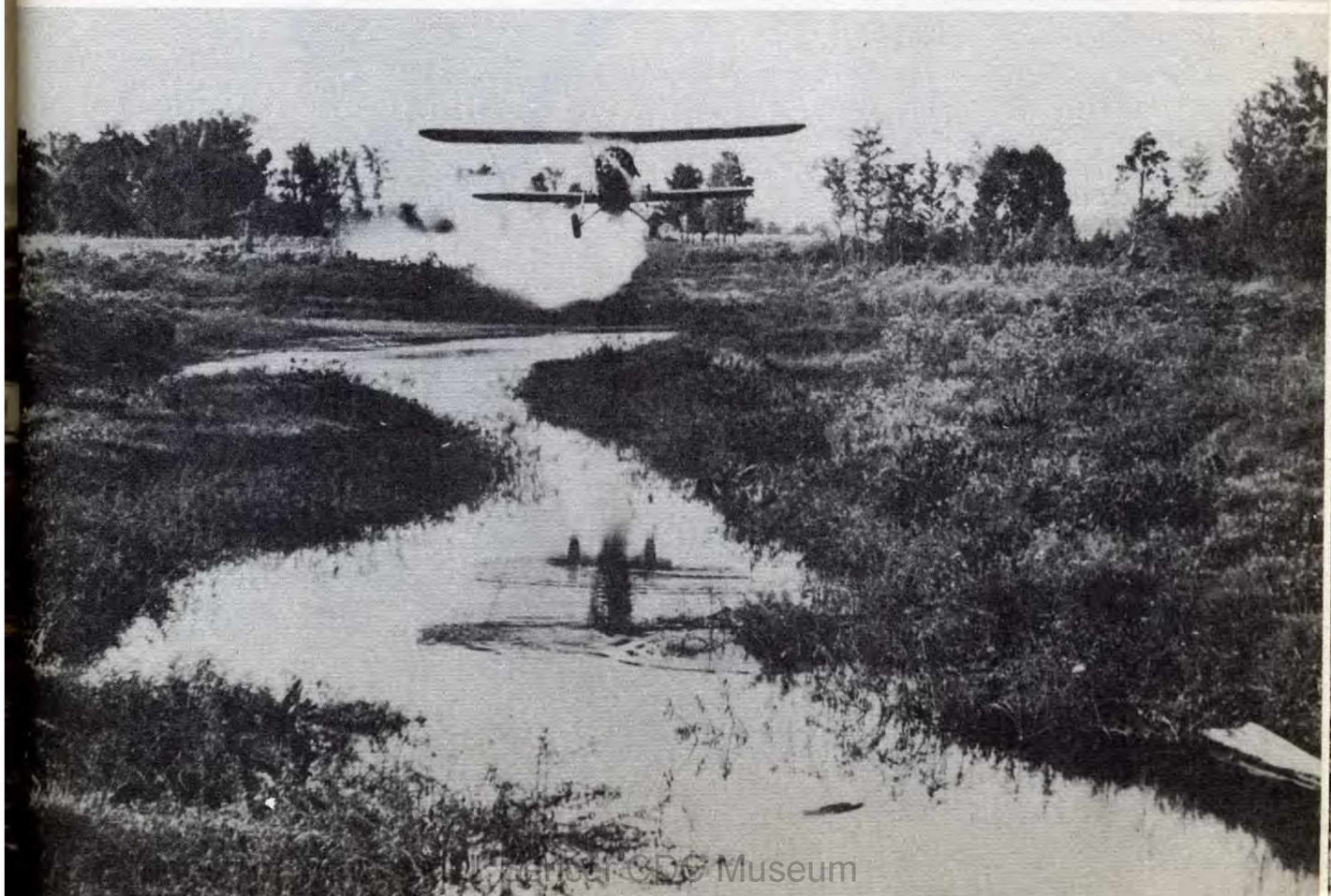
Forty-three species of mosquitoes have been recorded for the State of Tennessee. The following species were found for the first time by MCWA during the past fiscal year: *Aedes dupreei*, *fulvus pallens*, *grossbecki*, *mittchellae*; *Culex tarsalis*; and *Culiseta inornata*.

#### STATISTICAL DATA

During the year 3,493 acres were treated in 9 war areas protecting 68 war establishments. Some 12,408 houses were sprayed protecting 57,691 persons.

---

Dusting of anopheline breeding places.  
(Above) by boat; (below) by airplane.





# TEXAS

**GEORGE W. COX, M.D.**  
State Health Officer

## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray
- Extended Larviciding



## PROJECTS

- |                   |                       |
|-------------------|-----------------------|
| 1. Valley         | 9. Willeen            |
| 2. Caddo Lake     | 10. Fort Worth-Dallas |
| 3. Texarkana      | 11. Bastrop           |
| 4. Corpus Christi | 12. West Texas        |
| 5. Gulf Health    | 13. Wichita           |
| 6. Houston        | 14. El Paso           |
| 7. Port Arthur    | 15. Hidalgo           |
| 8. San Antonio    | 16. Lamar County      |

★ Austin

The State of Texas continues to have a large concentration of military establishments, essential war industries, and prisoner-of-war camps. The fiscal year saw a big increase in the number of POW camps, with at least half of them being located in the malaria sector.

## RE-EVALUATION OF CONTROL MEASURES

The problem in all 16 war areas of the State has been re-evaluation of the program and intensification of con-

trol measures. Through MCWA activities, some 245,861 persons were protected. Considerable economy was effected in manpower and materials by coordination of the entomological inspection service with control operations.

**MINOR DITCH CONSTRUCTION.** In order to reduce control work during the breeding season, much time was devoted to minor ditch construction, and to filling of numerous sink holes, abandoned slush pits and tanks.



of a small bulldozer and an operator from the Drainage Commission of Brazoria County, many lateral ditches were constructed leading to a large drainage ditch. This loan also facilitated the filling of numerous pot holes and low places.

**WATER HYACINTHS.** Constant removal of water hyacinths from drainage canals and swampy lakes is still necessary, and also removal of cattails from marshes.

**POWER EQUIPMENT.** Dusters, sprayers, and other power equipment were used to good advantage in the Houston, Lake Jackson, and Brownsville areas.

**OIL.** Waste oil, contributed by service stations and war establishments, was used on small, sluggish running streams, stagnant ponds and abandoned slush pits.

### AIRPLANE DUSTING OF PARIS GREEN

During the current year, airplane dusting of paris green was inaugurated in Orange and Jefferson Counties, which are located on the coast.

Two dusting operations were made approximately a month apart; 1200 acres of marsh area being covered in the first operation, and 1420 acres in the second.

The rate of application was  $1\frac{1}{2}$  pounds of paris green per acre per dusting. Immediately following the first dusting, there was a continued drought and low tides. During this interval, adult counts were low and few larvae were found.

Prior to the second dusting considerable rain fell which filled in the swamp areas with fresh water causing adult and larval counts to rise.

Larval checks revealed approximately 90% kill in the Jefferson County marsh. Adult counts were used to show the effectiveness of the operation in Orange County, as it was difficult to obtain larvae in sufficient quantities.

Because of the importance of mosquitoes in the epidemiology of malaria, a program for obtaining added reliable information on the distribution and abundance of individual mosquito species in the State was inaugurated.

Light traps were strategically placed in several non-MCWA counties in the northwestern part of the State where satisfactory arrangements for trap operation were made with the respective city and county health officers. In other places aid was solicited from city mayors, county judges, and superintendents of parks. The program was further designed as an adjunct to all entomological work directly connected with the present program, and direct assistance was given by the State Health Department.

### DDT SPRAYING OF POW CAMP

In the fall of 1944 there were 9 POW camps established in the counties of Colorado, Fort Bend, Brazoria, Wharton, and Jackson (all Area 5). A mobile unit was set up to control these camps, with utilization of prisoner labor. At the instigation of the Army, one camp was sprayed with DDT as an experiment. The Army supplied the material, while MCWA furnished the equipment and labor. A good job was done and favorable results were obtained.

### DDT HOUSE-TO-HOUSE SPRAYING

An individual house-to-house spray program on a county-wide basis, was begun last spring. Project proposals and plans were made and approved for operation in 3 counties in the Rio Grande Valley area and 3 in the eastern part of the State.

Spraying operations were begun in three counties in March and in two counties during the first week in April. Work in the other county was not started, due to the lack of equipment.



**SPRAY OPERATIONS.** Approximately 30,653 houses were sprayed, and entomological inspections were made to test the thoroughness of spray operations and the effectiveness of control.

**RECRUITING OF LABOR.** Practically all labor was obtained in a week through the cooperation of the Civil Service Commission.

**AUTOMOTIVE EQUIPMENT.** Automotive equipment was obtained from the Army through the Procurement Division. Supplies and equipment were furnished by the Headquarters office and through direct local purchase.

**MIXING PLANT.** A large warehouse and mixing plant was maintained at the State office where alterations and repair of equipment were made. From this central point, equipment and DDT concentrate were funneled to the various projects.

**PUBLICITY.** A public relations and educational office was set up to plan and coordinate all publicity attendant

to the program. Use was made of film strips, newspaper articles, and short radio talks. All work has been directed from the State level, and coordinated with the respective health unit.

### AEDES AEGYPTI

Most of the *Aedes aegypti* projects throughout Texas have been integrated with the local health units and are now doing general sanitation work. The integration activities include: *Aedes aegypti* control, a rat poisoning program, pest control, and DDT spraying of homes to control the fly population.

This program has been most successful in Houston, because of the complete cooperation of the city health department. In January 1945 when the integration began, there were 10 U. S. Public Health Service men and municipal employees. To date there are still 10 USPHS men but 56 inspectors are hired by the city.

LEFT. Covering barrel with screen to prevent *Aedes aegypti* breeding. RIGHT. School children learned to root house plants in earth to prevent *Aedes aegypti* breeding.







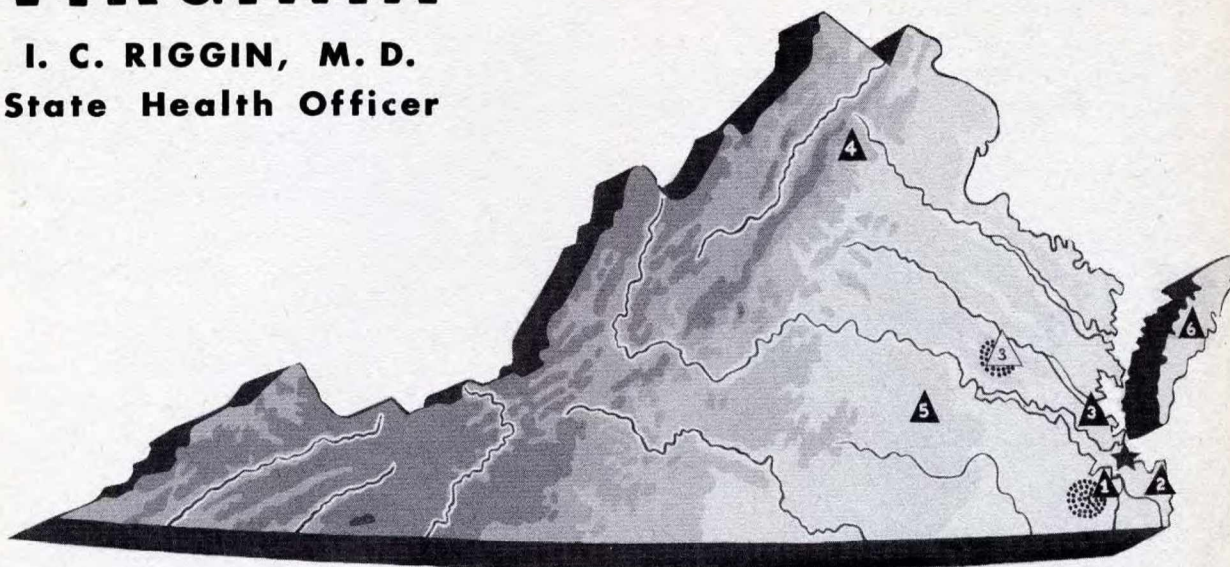
**ABOVE.** Anopheline breeding area created by irrigation ditching. **BELOW.** Hand ditching.





# VIRGINIA

I. C. RIGGIN, M. D.  
State Health Officer



## LEGEND

- ★ State Hdqrs.
- ▲ War Areas
- △ Extended Areas
- ▨ Residual Spray

## PROJECTS

1. Portsmouth
  2. Virginia Beach
  3. Pensular
  4. Northern Virginia
  5. Central Virginia
  6. Eastern Shore
- ★ Portsmouth

During the fiscal year 1945 control was done around 119 war establishments in the six war areas of Virginia.

The northern Virginia area along the Potomac River was combined with Maryland and District of Columbia MCWA work. This was practical from a geographical standpoint and also because of reduced work resulting from extensive cutting of water chestnut in recent years by the U. S. Engineers. This arrangement likewise allowed the Virginia organization to concentrate its efforts in Hampton Roads (Area 3) where the scope of work has increased.

The Army moved from Camp Pendleton, thereby eliminating several work sections. At the same time, new territory formerly within the Army's jurisdiction was added for the protection of Dam Neck Naval Training Reservation. The Norfolk Army Airport was demobilized but little reduction in work was possible because of the proximity of other war establishments.

## LARVICIDING

Small ponds and swamps, not easily accessible to conventional two-wheeled



trucks, were lavicided by a power sprayer rigged to a jeep. This most efficient piece of equipment was accomplished by mounting a motor and pump over a square tank placed on the floor of the jeep between the two rear wheels. A frame was built around the edge of the back which made the body larger and facilitated the carrying of hose, cans of oil and other equipment.

### SURVEILLANCE

Surveys have been made at all prisoner-of-war camps established in the State. Preliminary investigations generally showed no imported malaria cases, but several areas were put under further surveillance.

### PEST MOSQUITO CONTROL

By agreement with the FPHA, pest mosquito control was conducted in and around five large housing developments. Cost of the work was defrayed by a transfer of funds.

A pest mosquito control project in the off-post area around the Convalescent Hospital at Fort Story has been started by MCWA on a reimbursement basis. It was considered necessary to do substantial salt marsh drainage as well as oil larviciding in a five-mile belt around the Hospital. Inspection will be extensive, especially in the State Park area where wildlife interests requested that no control be done.

### LABOR

Throughout the entire war there has never been sufficient labor in the war areas of Virginia. In order to meet the labor shortage, German prisoners have been used whenever practical. It was found that on drainage projects, prisoners work very well, but it is not feasible to use them in spreading larvicide.

### ABANDONED MATERIALS

In the early stages of the war many small Army units were established in the Hampton Roads section as anti-aircraft and search-light stations. As the war progressed and need for this activity was eliminated, the Army abandoned many stations. The Virginia organization, through the Liaison Officer of the Third Service Command, was successful in obtaining the wreckage material from two of these camps. Twenty-two barracks were razed and over 75,000 feet of lumber were obtained at a cost of about \$20 per thousand. This figure represents the labor cost involved in razing buildings and cleaning lumber.

With this lumber, two buildings were built to house the MCWA activities in Virginia: one at Money Point, south of Hampton Roads, and the other at Hilton Village, north of Hampton Roads.

The latter has a field office and storage space for seven trucks. The former is a larger building having storage space for 15 trucks, a warehouse, offices, auto repair shop and carpenter shop. A grease rack, oil platform and plant for manufacturing concrete ditch linings have been installed in the yards. Three boats especially designed for lake dusting have already been built at the carpenter shop and the mechanical equipment is kept in repair by the personnel at the auto repair shop at a substantial saving to the government.

In each case the county purchased or owned the land on which the building was constructed and furnished a considerable portion of the material cost, such as roofing, siding, nails, and other hardware.

### DDT SPRAYING

The Extended Program has not been operated in Virginia, although a small



supply of DDT with equipment has been received. About 100 houses were sprayed for the purpose of instructing personnel in the technique of application. Thus, trained men with equipment will be available in the event of a malaria outbreak in Virginia or neighboring states.

### PERMANENT MOSQUITO CONTROL

In Virginia there is a law providing for mosquito control districts supported by local taxes. One such district has been in operation for the past five years and has proved its workability. With the present program serving as a demonstration, it is planned to organize other districts in areas where MCWA has operated. The work already done with MCWA funds will be the start of mosquito control on a permanent basis in Virginia, not merely a current expenditure of funds.

Several local subdivisions have shown sufficient interest in the plan to request assistance in setting up such an organization. Under this plan, the mosquito control district would contribute labor and equipment in sufficient quantity to permit a general mosquito control program.



Hand Dusting near Norfolk

Accordingly, malaria control would be able to survive the discontinuance of MCWA after the War. With a reservoir of trained personnel available, a relatively permanent malaria control program would be possible whenever federal funds are discontinued.

### PHYSICAL ACCOMPLISHMENTS

Paris green larviciding was done in city water supply lakes, and a few other places where oil was not permitted or was not feasible. A total of 4,499 acres was dusted with an average application rate of 4 pounds per acre, utilizing four man-hours per acre. Good results were obtained.

Other places were larvicided with oil. Approximately 963 acres were treated with oil with an average rate of 39 gallons per acre and 8 man-hours per acre.

Maintenance of existing ditches is important in Virginia because of the flat grades. Some 7,170 acres of ditches were cleaned and maintained and 342,670 linear feet of new ditches constructed. Since drainage in this area required extensive maintenance, the policy has been to install ditch lining wherever feasible and promote its use by other public and private agencies. An average of 1,672 linear feet of monolithic lining was poured.

As a result of the success attained with small ditch lining projects, it was possible to encourage and assist several counties in planning a \$500,000 drainage job which includes both storm drains and ditch lining.

### AEDES AEGYPTI

A survey conducted in Norfolk during October of 1944, showed a high index of *Aedes aegypti*. As a consequence of this survey, the U. S. Public Health Service has initiated programs in Norfolk and Portsmouth. The cities involved are matching federal personnel with employees on their pay rolls.





**CONCRETE PRODUCTS PLANT.** Ditch lining was manufactured at Money Point.



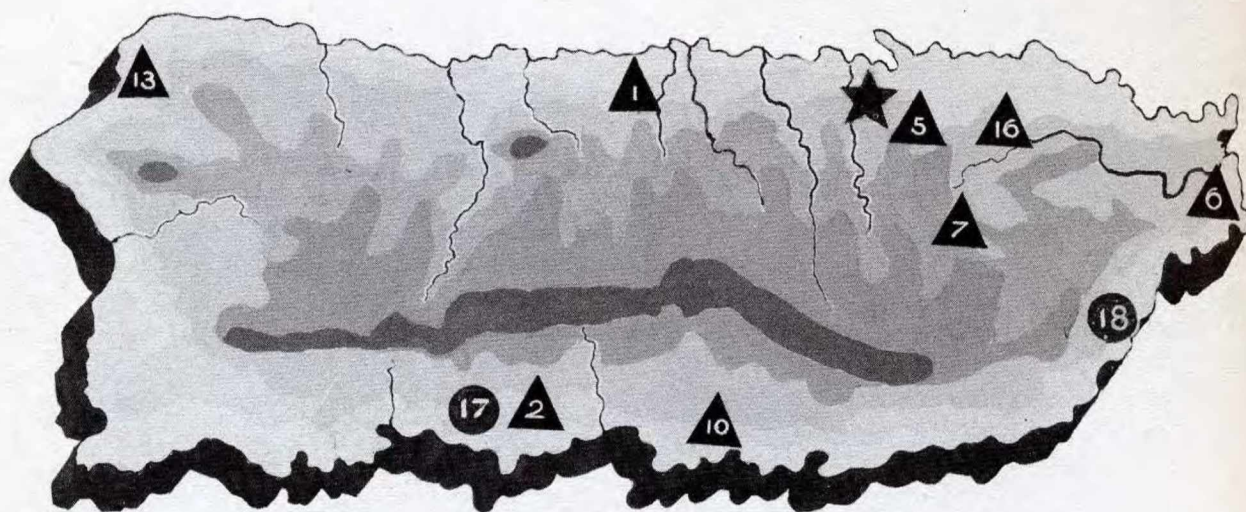
**LINED DITCH.** In Virginia 7,170 acres of ditches were cleaned and maintained; 342,670 linear feet of new ditches were constructed.



# PUERTO RICO

EDUARDO GARRIDO MORALES

Territorial Health Officer



## LEGEND

- ★ Island Hdqrs.
- ▲ War Areas

## PROJECTS

- |                               |                      |
|-------------------------------|----------------------|
| 1. Camp Tortuguero            | 10. Salinas          |
| 2. Losey Field                | 13. Boringuen Field  |
| 3. Fort Buchanan              | 16. Carolina         |
| 5. Insular Wide (Rio Piedras) | 17. Ponce            |
| 6. Ensenada Honda             | 18. Playa de Humacao |
| 7. Camp O'Reilly              | ★ San Juan           |

Malaria has continued to decrease among military personnel during the three consecutive years that MCWA has been operating in Puerto Rico. Work has been accomplished in close coordination with the Army, Navy and Insular Health Departments.

MCWA activities were restricted to areas immediately adjacent to military reservations until April 1945. At that time a cooperative Insular Health Department-MCWA comprehensive planning survey was begun in the vicinity of the city of Ponce, the second largest civilian population concentration on the Island.

Of necessity, MCWA activities in Puerto Rico differ considerably from those in the continental United States. For example, through an agreement with the Insular Health Department, MCWA has been operating its projects independently in areas immediately adjacent to Army and Navy bases with a known malaria problem.

The Bureau of Malaria Control of the Insular Health Department agreed to furnish certain key personnel and materials to MCWA on an exchange basis and to continue its extensive drug treatment program, particularly in



In all cases, the object has been the reduction of existing malaria among military forces rather than protection against a potential malaria hazard.

Initiation of control operations has been confined solely to camps with actual malaria incidence and sufficient military strength to justify intensive control activities on a large scale.

Initial reduction in malaria transmission among military personnel was accomplished in some camps as early as the fall of 1942 following intensive larviciding, mosquito proofing of military structures, and routine application of malaria discipline. The objective has been to reduce further and to maintain the military malaria rate at a level commensurate with expenditures for malaria control.

### SPECIES OF MOSQUITOES

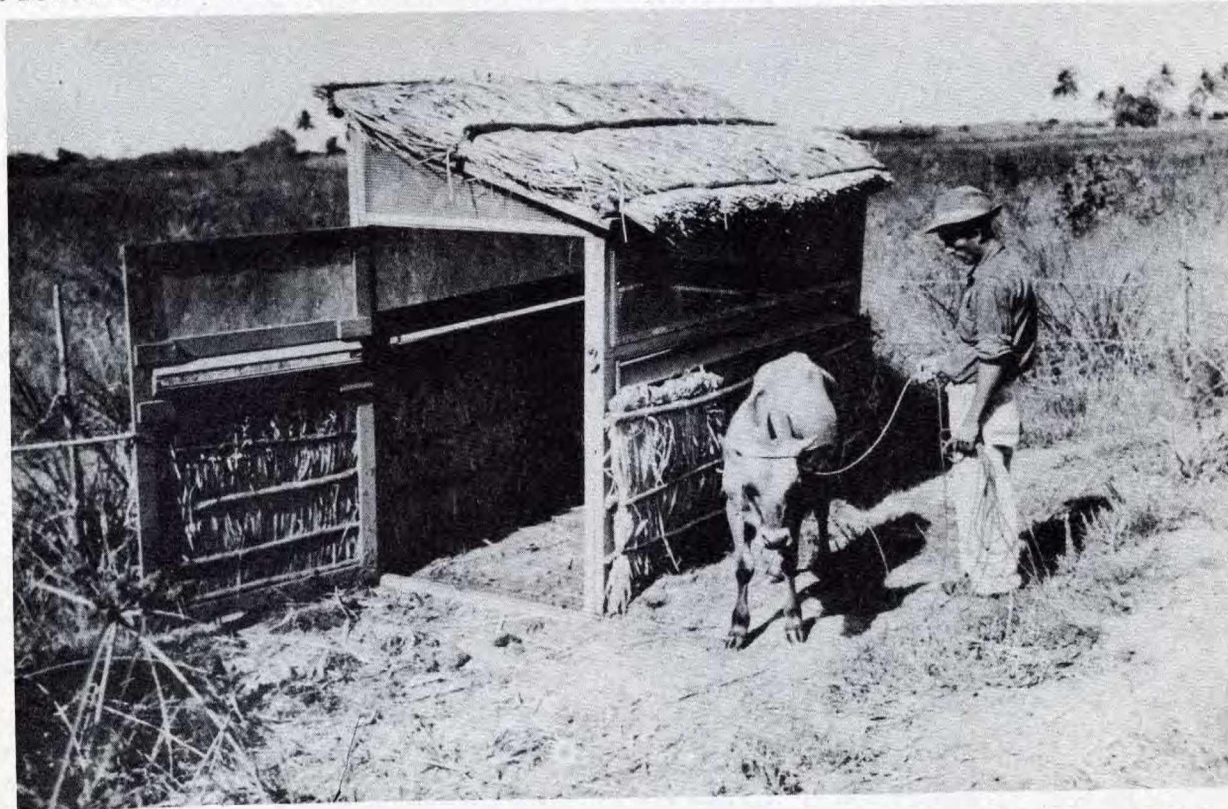
The principal malaria vector in Puerto Rico is *Anopheles albimanus*,

prevalent in the eastern United States, *Anopheles freeborni* in the southwest, or even *Anopheles albimanus* in the lower Rio Grande Valley of Texas.

In the Greater Antilles, *A. albimanus* breeds in a variety of aquatic situations including fresh and brackish water. It has at least a two-mile flight range, does not rest in large numbers in daytime resting places and is easily collected in light traps.

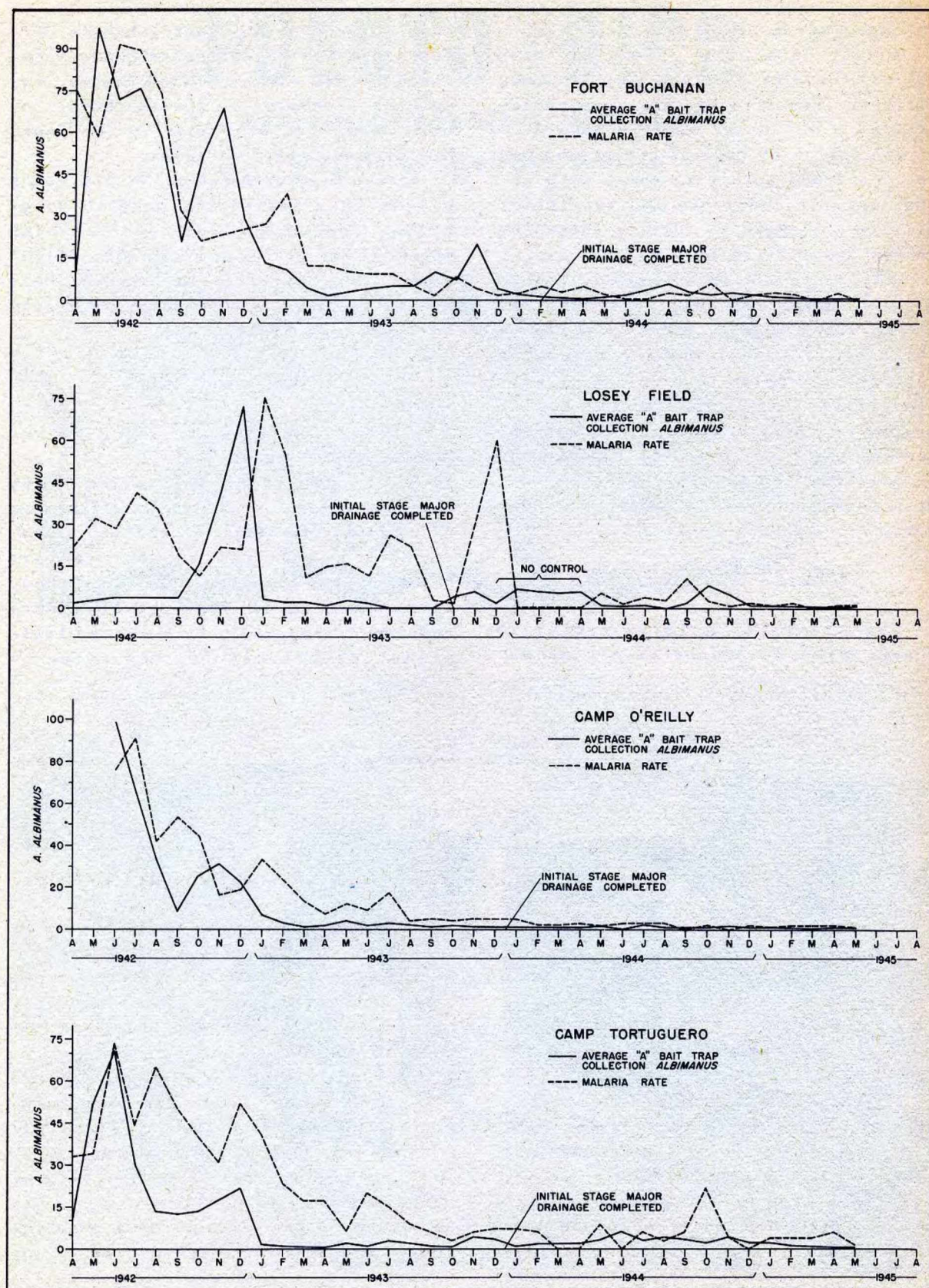
### ANIMAL BAIT TRAPS

Animal bait traps, using either horses or calves as bait, are utilized as index stations in locating heavy breeding areas, or in judging efficiency of control activities. After three years' control operations around military bases, it has been found that in a population living in screened buildings and exercising ordinary malaria discipline, relatively few new cases of



ANIMAL BAIT TRAP at Camp Tortuguero. Bait traps are used as index stations in locating heavy breeding areas, or in judging efficiency of control operations.







The chart indicates the reduction in malaria rate among military personnel and the size of average, overnight, animal bait trap collections of *A. albimanus* in the intra-cantonment zones at four major Army posts where MCWA projects have been in operation from 1942 through the fiscal year 1945.

The graphs show a great reduction in average *albimanus* collections during this period as a result of major drainage activities by both the Army and Public Health Service. The military rate has been plotted as a trend.

1. Graph for Fort Buchanan shows a downward trend in military malaria.

2. The Losey Field graph indicates a seasonal rise in numbers of *albimanus* and a higher malaria rate than at the other three projects. During the rainy season from May through November, there are more breeding places and more *albimanus* produced than during the dry season from mid-December to April. The graph for the years 1942 and 1943 is almost a classical demonstration of the principle that the malaria rate rises and falls one to two

months after similar rises and falls in *albimanus* populations. The peak in malaria rate in September 1944 before the seasonal increase in *albimanus* population has occurred, is the result of the Army reporting system. A large number of soldiers had been on field maneuvers in a highly malarious part of the Island two to three weeks before they returned to Losey Field, where the clinical symptoms of malaria became evident. These cases are therefore reported from Losey Field, even though there is good epidemiological evidence that these soldiers were infected while on maneuvers off the Post.

3. Graph for Camp O'Reilly, like the one for Fort Buchanan, shows a downward trend in military malaria.

4. Graph for Camp Tortuguero indicates a downward trend in malaria from 1942 through 1945, with the exception of one peak in October 1944. This rise in malaria rate was apparently caused by soldiers returning from maneuvers, rather than from infections contacted on the Base, as previously explained for Losey Field.

---

malaria are contracted when counts in "A" station bait traps can be kept at an average of two to five female *albimanus* per trap per night. In unscreened civilian villages near these camps, the counts must be kept at an even lower level to provide adequate protection.

### LIGHT TRAPS

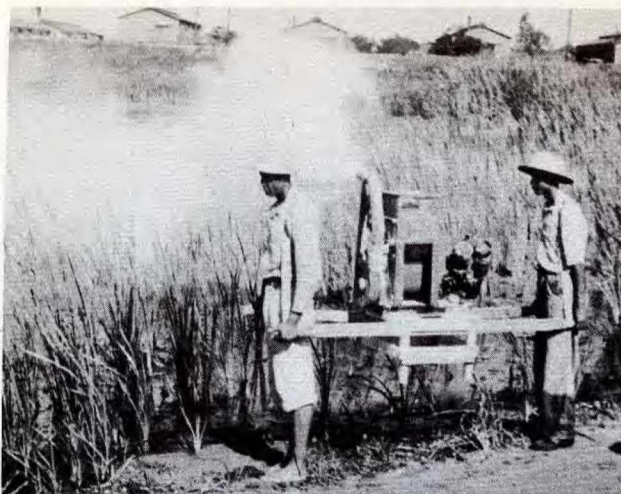
Light traps in general collect more *albimanus* than animal bait traps. However, light trap collections show such a regular alternation of high and low counts correlated with the lunar cycle that great care must be taken in interpreting light trap data.

### MOSQUITO COLLECTIONS AND MALARIA

MCWA has been operating for three years at Camps O'Reilly and Tortuguero. No animal bait trap in intra-cantonment zones had collections of 5 *albimanus* or more during any 3 consecutive weeks of the fiscal year 1945.

At Fort Buchanan the average for 8 intra-cantonment bait traps was below 5 *albimanus* per trap per night throughout the year, except during August 1944, when the average was 6.4 *albimanus*. However, one bait trap had counts of 5 to 56 *albimanus* per night most of the time from July through November 1944. Since December 1944, control has been at a satisfactory level throughout the Post.





POWER DUSTING from manually transported equipment. Both hand and power dusters are used in applying paris green to watered areas.

Control at Losey Field was satisfactory throughout the year except during the rainy season months of October and November, when collections in 2 intra-cantonment bait traps rose above the arbitrarily assumed safe level of 5 *albimanus* or more, for 3 successive weeks. During this time, the wind shifted from northeast to northwest. The prevailing wind in this particular area is from east to west, consequently, the control zone west of the Base is normally limited to about 1.5 miles.

The MCWA project at the Salinas Training area has operated intermittently. An explosive outbreak of malaria occur-

red in September and October of 1944, but was brought under control by mid-November by intensive larvicidal and minor drainage activities and a DDT residual spray program of the Army and Public Health Service. No malaria has been reported from this Base since December of 1944.

At Fort Bundy where there are no major drainage operations in progress, more than a thousand female *A. albimanus* were collected in single intra-cantonment bait traps on individual nights during the months of June, July, August, and September 1944. Despite an extensive larvicidal and minor drainage program by both Army and Public Health Service, counts continued to rise from June through September. In October 1944, all control by standard methods was abandoned and arrangements were made with the Army for airplane dispersal of DDT in Diesel oil. A spectacular drop in anopheline mosquitoes occurred in less than a month and became so marked in January 1945 that all control except by drainage was stopped until June 1945 when airplane spraying with DDT in Diesel oil was resumed.

The only malaria cases reported from Fort Bundy were a Signal Corps officer stationed on night duty off the Base and two auxiliary military police on night duty at the Main Gate, remote from military housing areas.



Power Dusting from a Jeep.



Through a cooperative agreement with the U.S. Navy, airplane dusting is done at the Fort Buchanan-San Patricio project. The Navy provides the plane and pilot while MCWA furnishes the larvicial dust which is a mixture of paris green and hydrated lime.

Airplane dispersal of DDT in Diesel oil was used successfully at Fort Bundy to control a serious outbreak of *A. albimanus* after larviciding supplemented by minor drainage, had failed to provide control. MCWA supplied data regarding larval and adult mosquito collections and a considerable portion of labor; the Army provided the airplane, pilot, DDT and Diesel oil. The plane is also available to treat simi-

lar areas at other bases where usual control methods prove inadequate.

### DECONTAMINATION UNITS

Knapsack sprayers are used at the Camp O'Reilly project to oil the municipal reservoir of a nearby town in order to control breeding within a mile of the Base and still not contaminate the drinking water of the municipality.

Army decontamination units have been used at three projects to carry oil into the field and mix it under pressure as an oil-water emulsion. This emulsion is sprayed on watered areas by hoses attached to the decontamination unit tank, or from ordinary sprayers filled from the truck in the field.



Spraying with Army decontamination unit. Army decontamination units have been used at three projects to carry oil into the field and mix it under pressure as an oil-water emulsion.



### CABLE SAW

At Camp Tortuguero, heavy growths of pondweed, pond lilies, and hornwort were formerly removed by men standing in ditches and cutting vegetation with machetes. Last year a cable saw was devised which has proven time-saving and labor-saving. It is operated by two men standing on either bank of a ditch and cutting aquatic growth by pulling the cable back and forth.

### STREAM MAINTENANCE

Clearing and cleaning is an important phase of ditch and stream maintenance because *albimanus* breeds prolifically in streams. In hilly sections, stream maintenance and stream channeling have saved much labor and larviciding. After two or three years of cunetting however, some streams have had considerable vertical and lateral erosion.

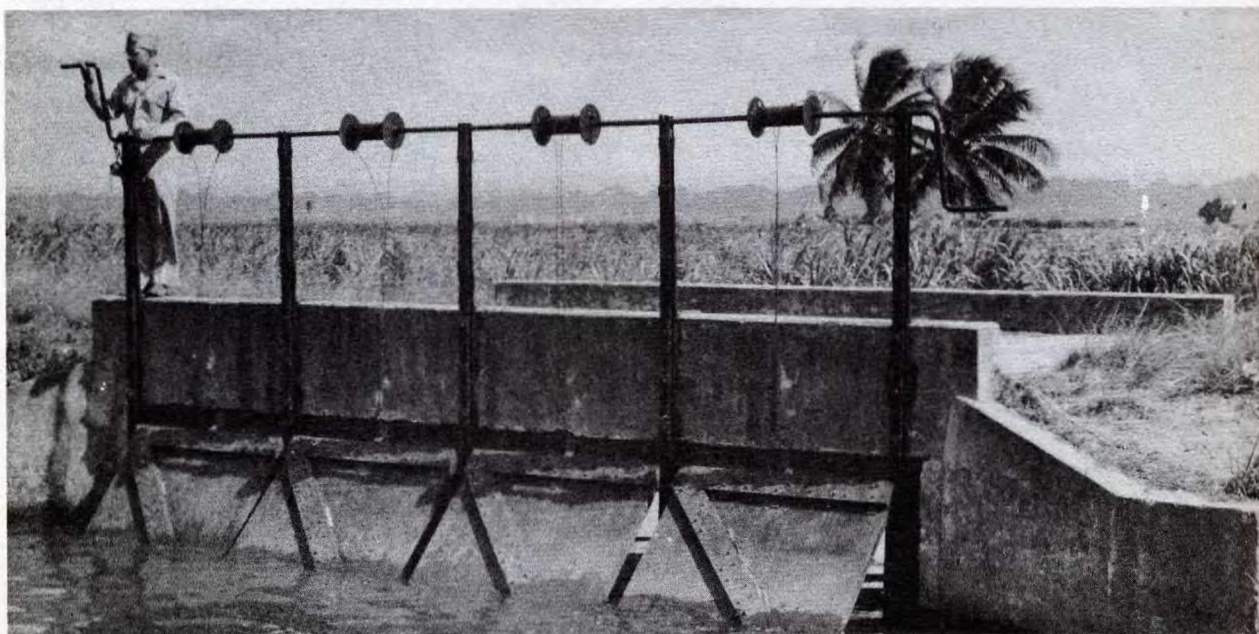
### GRADE MONUMENTS

In order to prevent further erosion and reduce the cost of stream maintenance, grade monuments have been installed in streams at 75-foot to 100-foot intervals at a cost of about \$.28 a linear foot of stream bed as com-

pared with \$1.00 to \$2.25 a linear foot for inverting these same streams. The grade monuments are of precast, reinforced concrete, 6'x15" with 3" thickness. Many of these have been completely hidden by depositing silt. Consequently, building-up of stream beds is occurring rather than continued vertical and lateral erosion.

### TIDEGATES

At Camp Tortuguero, March and most of April were devoted to maintenance work on a drainage system with approximately ten miles of major canals. Tidegates were installed on the main eastern outlet canal to prevent sea water or fresh flood water from the Rio Cibuco backing up in the canals and flooding the thousand-acre swamp east of Camp Tortuguero. These tidegates are of novel design. The pivot points of each gate ride in channels so that the four gates may be raised entirely from the water, thus allowing maximum discharge during the dry season. It was also necessary to provide arrangements for raising the gates during the periods of low outward flow because of the flat grades and low head.

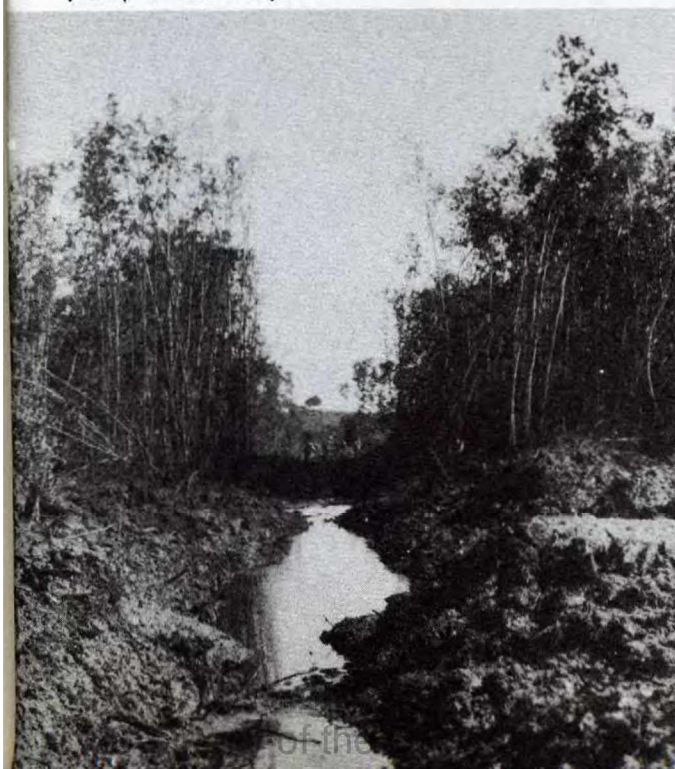


TIDEGATES. These were installed on the main eastern outlet canal to prevent sea water or fresh flood water from the Rio Cibuco backing up in the canals and flooding the 1000-acre swamp east of Camp Tortuguero.





ABOVE. Cable saw removing vegetation in drainage canal. This method has proved more economical in both labor and time. Men formerly removed vegetation with machetes. BELOW. (Left) Ditch in mangrove swamp after initial dynamite blasting (Ft. Bundy). (Right) Grade monuments installed in upland streams to prevent vertical and lateral erosion (Camp O'Reilly).



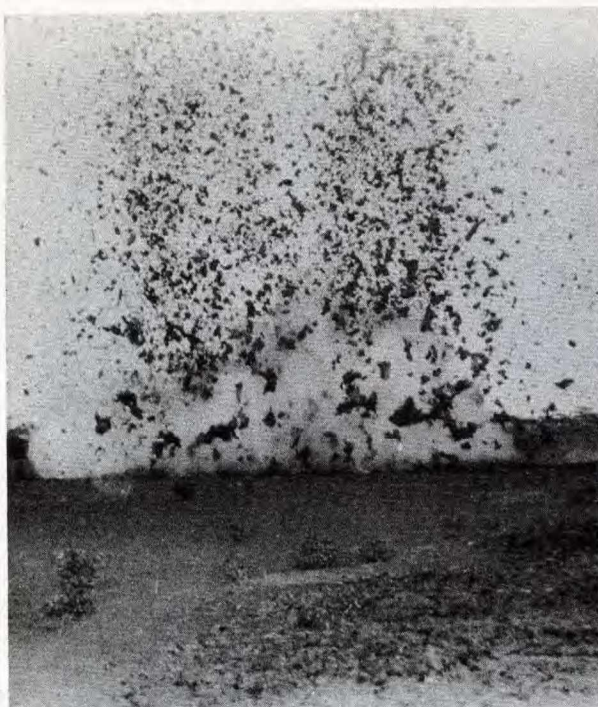


## MAJOR DRAINAGE

During the past three years at all Army posts with significant malaria hazard, the U. S. Engineers and Post Engineers have carried out intra-reservation major drainage programs of permanent type, where experience and entomological data have indicated that satisfactory control could not be obtained by larviciding alone.

The same is true of Naval installations where similar, permanent drainage has been prosecuted under the direction of the Officer in Charge of Construction. In one instance a large extra-reservation pumping station and drainage system were constructed by U. S. Engineers.

In the extra-cantonment zone, MCWA has carried on extensive drainage where satisfactory control could not be obtained by other measures. There has been constant cooperation among Army,



**DYNAMITE DITCHING** at Ft. Buchanan. This method was used to provide adequate outlets into major drainage canal where streams had been blocked by hydraulic fill.



**PANAMA INVERTS** installed outside Ft. Buchanan. MCWA installed precast Panama inverts and side-slabs in the extra-cantonment portion of two streams which had already been inverted inside the reservation by the Army.



intra-cantonment and extra-cantonment drainage programs. At Fort Bundy a network of old ditches in an extensive area of abandoned sugarcane fields and pastureland was renovated by MCWA. A temporary pump was installed by the Post Engineer to drain the large extra-cantonment breeding area west of this Base, and the western portion of the intra-cantonment zone.

At Fort Buchanan, MCWA installed precast Panama inverts and side-slabs in the extra-cantonment portion of two streams which had already been inverted inside the reservation by the Army.

The lower portion of both of these streams had been blocked by hydraulic fill, so dynamite ditching was employed to provide adequate outlets into a major drainage canal.

Dynamite ditching was also employed at Fort Bundy to provide an adequate outlet ditch through Mangrove swamp for the discharge from the temporary pump-house.

### OTHER ACTIVITIES

At the request of the School of Tropical Medicine, 6 students of the Division of Health and Sanitation of the Coordinator of Inter-American Affairs, 3 Chinese physicians, and 18 sanitarians of the Puerto Rico Insular Health Department have been shown various MCWA projects in Puerto Rico during the year. Students on scholarships of the Coordinator of Inter-American Affairs have come from Peru, Panama, Costa Rica, Honduras, Santo Domingo, and Haiti.

Some have been interested in merely seeing the MCWA projects which are among the largest in the Caribbean area. Others have spent a month or more studying mosquito adults and larvae in detail, actually working on projects and learning malaria control from personal experience.

The 18 sanitarians of the Insular Health Department were given a 2-weeks'

Lectures on malaria control have been given by the District MCWA entomologist to four groups of Army officers, and illustrated slide lectures have been delivered to Farm Security Agency representatives at their quarterly meetings.

### DDT RESIDUAL SPRAYING

In October 1944, the Atlanta Headquarters of MCWA sent three commissioned officers to Puerto Rico to determine the value of DDT in killing *A. albimanus* and if possible, the value of this method of mosquito control in reducing malaria incidence.

The U. S. Public Health Service and Insular Health Department selected Humacao Playa and Loiza Aldea as test and check areas because these two towns had the highest known malaria rates among the civilian population where no malaria control measures had been practiced. They were also comparable in size, type of houses, racial composition, rainfall, geographical location, and general ecological habitat.

Blood film surveys were made by personnel of the Insular Health Department. The first survey was made in October 1944; the second in March and April 1945; the third will be made in October 1945. The blood slides were sent to San Juan for staining by a MCWA technician and then sent to the Memphis Laboratory of the National Institute of Health for examination.

The first spraying of houses in Humacao Playa was done during the first three weeks in November 1944, and the second spraying was during the last two weeks in June 1945.

Available data indicate that the action of DDT on *albimanus* in Puerto Rico is about the same as on *quadrimaculatus* in the continental United States. There is no indication yet that DDT residual spraying controls actual transmission of malaria in Puerto Rico.





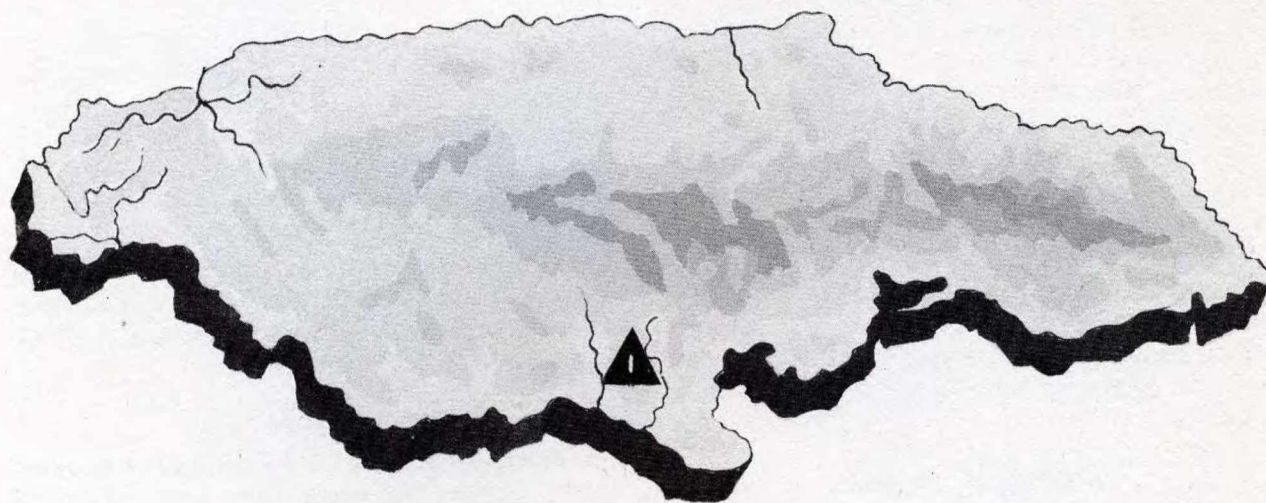
Member of a DDT spray crew visiting typical houses in Humacao Playa. The first spraying of houses was done in November 1944 and the second in June 1945. Available data indicate that the action of DDT on *Anopheles albimanus* in Puerto Rico is about the same as on *quadrimaculatus* in the continental U. S.



DDT Truck and Crew in Native Village. In October 1944, commissioned officers of USPHS were sent to Puerto Rico to determine the value of DDT in killing *A. albimanus*.



# JAMAICA



## LEGEND

▲ War Area

## PROJECT

1. Fort Simonds

★ Hdqrs. San Juan, P.R.

The Fort Simonds, Jamaica project is the only MCWA project located in a foreign country. The Base is a lend-lease airfield entirely surrounded by Jamaican-owned or British-owned land. Considerable caution must therefore be exercised in work in the extra-cantonment area in order to avoid complications with the Jamaican government and local agencies.

The Base is situated in the flat coastal plain of southwest Jamaica where many sink holes, cattle ponds, and gullies along streams provide ex-

cellent breeding places for malaria mosquitoes. During the rainy season, water stands for weeks or even months on the gumbo-like soil and is ideal for the production of *Anopheles albimanus*, the malaria mosquito of this island.

## ENTOMOLOGICAL STUDIES

Four light traps and nine animal bait traps were operated on the Base or within a 1-mile zone around the Reservation where at least 44 species of mosquitoes have been reported.



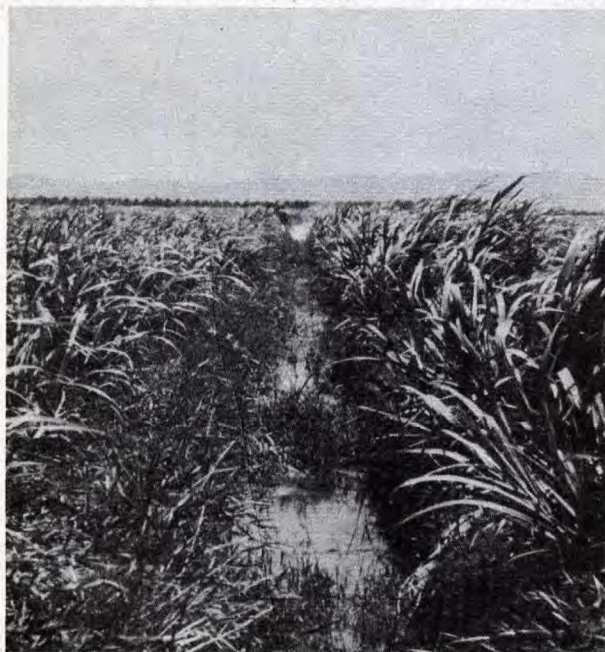
A separate Army warehouse is used for storage of lime and paris green and mixing of dust with an eccentric barrel mixer. Two half-ton Ford pickup trucks and four bicycles are available for transportation.

The MCWA supervisor directs both the Post Engineer's crew of 3 larvicidal men working with oil inside the Base, and 17 USPHS employees composed of a general foreman, 2 crew foremen, 2 inspectors, 1 animal bait trap operator, and 11 larvicidal men using paris green outside the Base.

During the fiscal year 1945, extra-reservation malaria control operations at the Jamaica Base Command were performed by the U. S. Public Health Service at a cost of approximately \$14,000. About \$11,000 was expended through Army channels to meet pay rolls for native laborers and local material purchases.

### SUCCESS OF PROGRAM

The success of the program is attested by the fact that only two cases of military malaria have occurred since control operations were started 16 months ago. Both cases were men who



were assigned to night duty.

No seasonal rise in *albimanus* population has occurred since the beginning of the project in May 1944, although pest mosquitoes, particularly *Psorophora*, have at times been numerous and troublesome to ground crews servicing airplanes between sunset and sunrise.

### CONTROL

Most control is by larviciding. Little drainage is done outside Fort Simonds because the country is very dry half the year, and local people need all the water for personal use or for live stock. However, a 2,200-foot ditch is being constructed just outside the reservation limits. There is also considerable cleaning and clearing in the already constructed ditches.

### PROJECT OPERATIONS

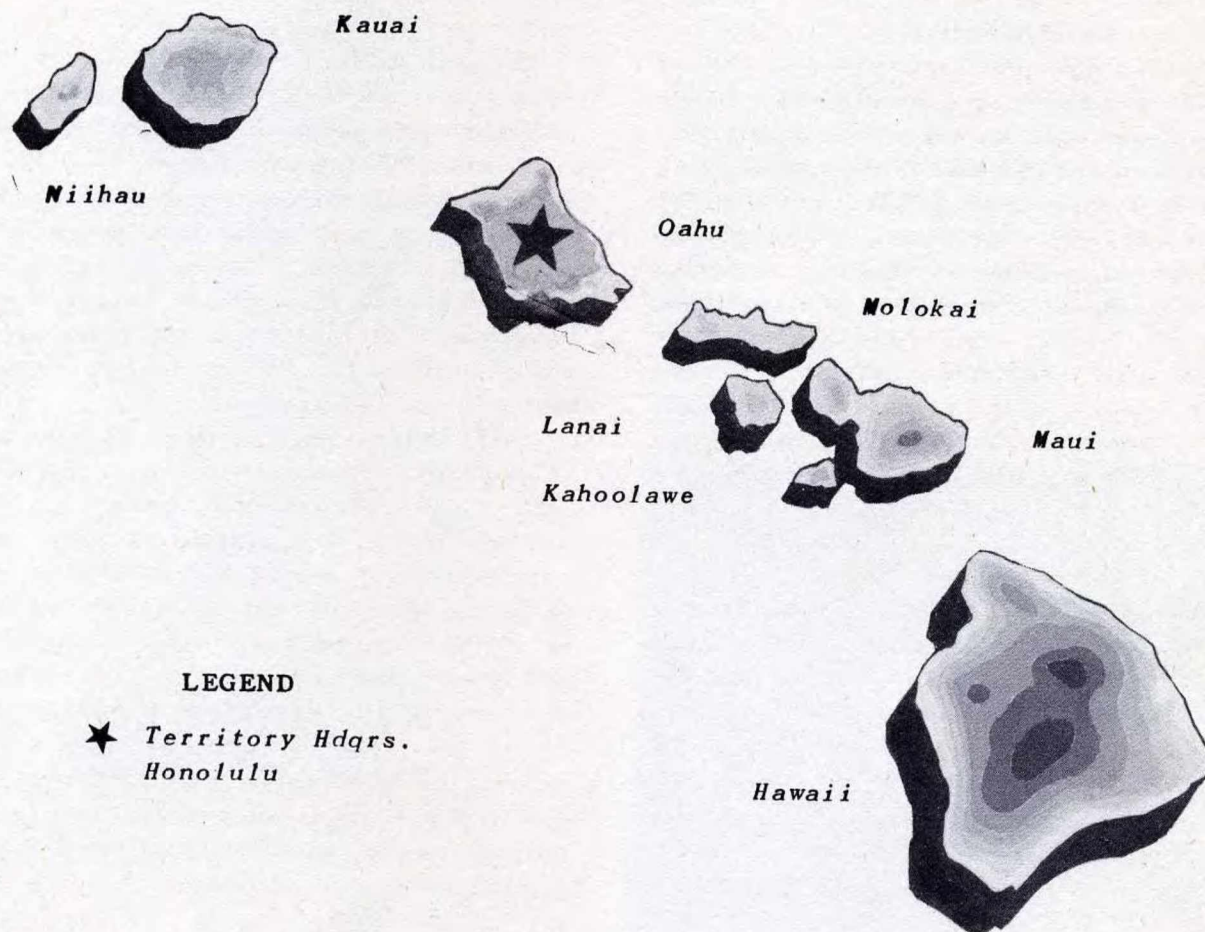
Excellent field headquarters for MCWA activities were made available by the Army. The MCWA office is the original Post infirmary, fully equipped with hot and cold water, electricity, typewriter, storage space, and other facilities.



LEFT. Irrigated sugar cane field is source of breeding. RIGHT. Hand Dusting. Most control in Jamaica is by larviciding. Little drainage is done outside Ft. Simonds because the country is very dry half the year and the water is needed for personal use.



**C. L. WILBAR, JR., M. D.  
President, Board of Health**



**LEGEND**

★ Territory Hdqrs.  
Honolulu

The mosquito-borne disease of greatest concern to the Territory of Hawaii is not malaria, but dengue. This disease was introduced from the South Pacific in July 1943, reached its peak in November 1943 and was brought under control by June 1944. Sporadic cases were reported during the summer of 1944. Two cases in early March 1945 and nine cases in May and June 1945 indicated a possible new introduction.

The Hawaiian Islands, with their excellent Pacific Ocean quarantine barrier, have only three species of mosquitoes:

*Aedes aegypti*, *Aedes albopictus*, and *Culex quinquefasciatus*. The control program is directed against the two dengue vectors, *Aedes aegypti* and *Aedes albopictus*.

Approximately 350 sanitary and military personnel were engaged in the program by July 1944 and 156 men by June 1945. The territory-wide *Aedes* program continued until the fall of 1944 when Army personnel on Kauai, Maui, and Hawaii were withdrawn. Activities in Honolulu, rural Oahu, and Hilo, Hawaii were continued. Honolulu,



containing half the population of the Territory, is the main port of entry for all air travel and practically all sea travel. During the 1943 dengue epidemic, all dengue cases occurred in Honolulu or were directly traceable to a Honolulu contact.

### PUBLICITY

Residents were urged to rid their premises of all mosquito breeding. Hand bills were distributed and radio talks and lectures were given. During the year 534 column inches of English and 300 column inches of foreign language articles appeared in various publications.

### MOSQUITO DAY

In October of 1944, a school Mosquito Day program was inaugurated in 49 schools on Hawaii and 21 schools on Maui in cooperation with the Department of Public Instruction. Talks were given at all schools, presenting basic facts concerning *Aedes* mosquitoes and dengue fever. Students made inspections of their homes once a month for *Aedes* breeding and eliminated the containers in which breeding was found. During the school year 89,322 students reported finding 178,190 containers of which 56,089 were found to have wrigglers.

### PREMISE INSPECTION

Originally, premise inspection activities were initiated in all areas by assigning individual inspectors to single zones to be inspected on a 10-day cycle. In Honolulu 77 inspectors were required to cover the 77 zones.

Following reduction in manpower, several zones were assigned to each foreman and crew of four to six inspectors, with all inspectors working in one zone under the close supervision of the foreman until that zone was completed. Zones, in which the dengue fever hazard was considered greatest, were worked on a 10-day to 12-day inspection cycle,

while all other zones were worked as often as manpower permitted.

Routine inspections were made of 922,778 premises during the year. Of these 11,238 were found breeding *Aedes* mosquitoes.

### LARVICIDING

**DIESEL OIL.** Crews on motorcycles were organized to larvicide catch basins and other permanent breeding places reported by the premise inspectors. These include storm drains, manholes, ground pools, swamp areas, ditches, cesspools, and bomb shelters. A power sprayer was used to larvicide large swamp areas and streams. The breeding spots reported were larvicided on a regular 10-day cycle until corrected.

**PYRETHRUM.** To minimize the danger of possible secondary cases of dengue, houses of patients were sprayed inside and outside with a pyrethrum spray mixture. Three hundred and thirty-eight premises were sprayed using 400 gallons of pyrethrum emulsion. Approximately 100 homes were sprayed with sure-shot sprayers using pyrethrum propelled by Freon gas. One school containing 92 rooms and 2 theaters containing 722 and 1,089 seats respectively were also sprayed using pyrethrum extract diluted with 3 parts of kerosene.

### FISH

A widespread fish-stocking program was inaugurated. During the year 66 fish-ponds, 37 barrels, 7 ground pools, 4 swamps, 3 streams, 2 ditches, 2 catch basins, as well as numerous cisterns, were stocked with mosquito minnows to prevent mosquito breeding.

### PHENOTHIAZINE STRIPS

Phenothiazine strips prepared by the entomological staff fulfilled a definite need in the control program. Water-proofed pint jars filled with phenothiazine strips were suspended from all



flower vases and urns.

Envelopes containing phenothiazine strips were distributed in hotels and office buildings with data for use. No breeding has been found where strips have been used.

### COOPERATION WITH SANITARY DIVISION

Activities of dengue mosquito control inspectors and sanitation inspectors of the Board of Health were coordinated. It was agreed that dengue mosquito control inspectors during their premise-to-premise inspections would inspect premises for the following: overflowing and improperly covered cesspools, leaking plumbing and broken sewers, heaps of garbage containers at food establishments.

Whenever one or more of these conditions were observed, the inspector referred them to the Oahu inspection staff. This section provides for the handling of referrals, abatement by the sanitation inspectors and notification to the mosquito control section of the abatement of these nuisances. Difficult problems of mosquito control which require the issuing of abatement orders by the Board of Health are included.

### EXPERIMENTS

An entomological laboratory was maintained for the critical review and improvement of control operations. Routine work included the examination of all larval specimens collected by the premise inspectors, the preparation of phenothiazine strips and maintenance of *Aedes* mosquito colonies for experimental purposes.

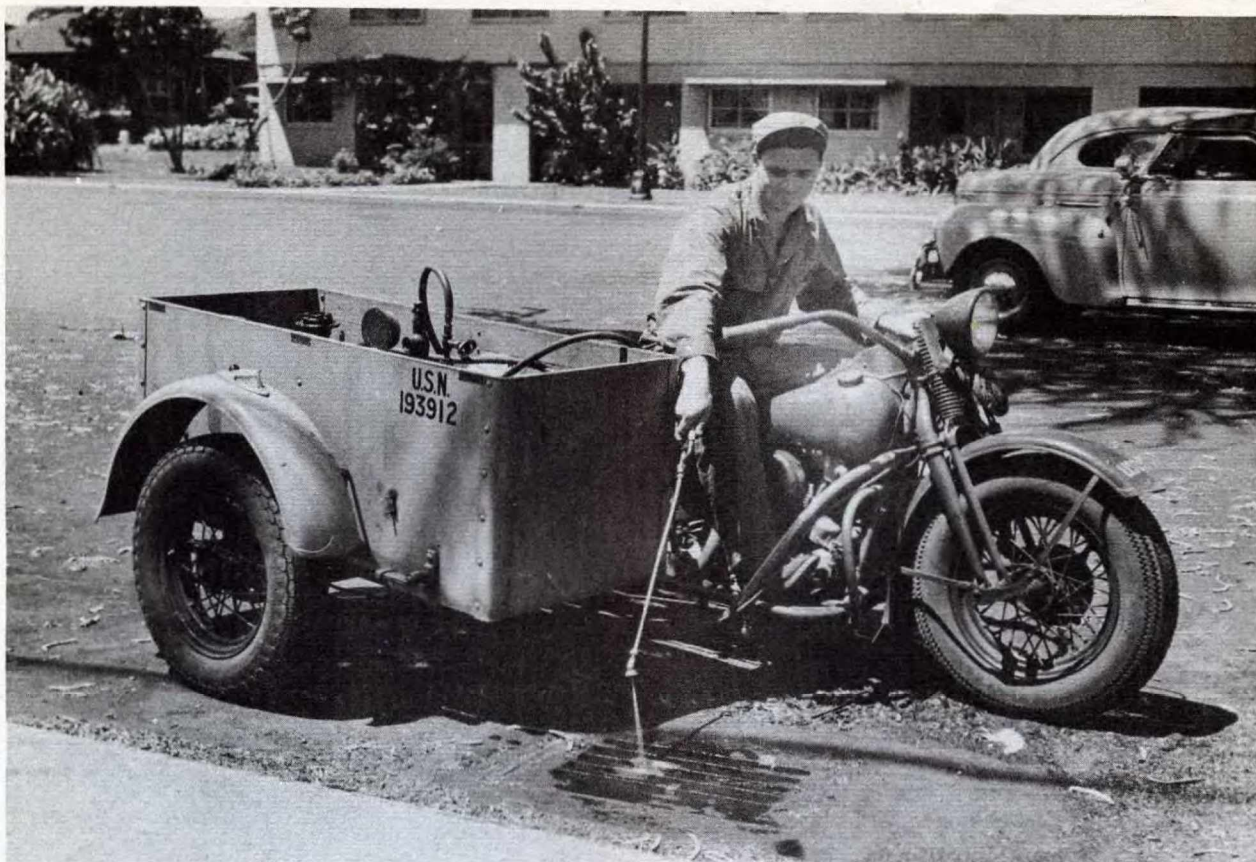
The average dispersal range of *Aedes albopictus* was experimentally determined to be less than 200 yards.

breeding in axils of lily and aloe plants. It is necessary to find a method of treating these plants which does not harm the plants but gives a lasting control. Paris green and kerosene injured the plants, and phenothiazine was difficult to use. The effect of DDT in combination with various solvents and emulsifiers on plants was investigated. While detrimental effects were obtained from the emulsifiers and several solvents, no damage to the plants resulted from DDT and ethyl alcohol. Field tests indicate that automatic applicators can be used to apply this form of DDT effectively for *Aedes* control.



*Aedes* breeding in bucket containing rooted plant.





**ABOVE.** Motorcycle larviciding unit using Diesel oil No. 2 to larvicide catch basins.  
**BELOW.** This trash pile provided numerous breeding places for dengue mosquitoes. A total of 922,778 premises were inspected during the year.

